APRIL 2012

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CURABLE CANCER
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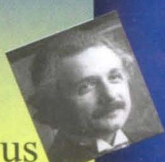
Science Reporter

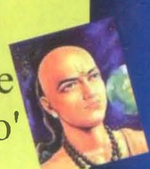
A CSIR PUBLICATION

Mathematics Special

The World Cannot Do Without Indo-Arabic Numerals

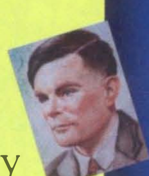


- World-famous Mathematicians

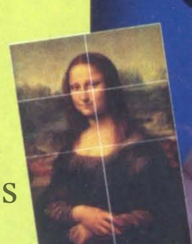


- Inventing the mighty 'Zero'

- Ingenious Ramanujan



- 100th Anniversary of Alan Turing



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VOL. 49 NO. 4 APRIL 2012 ISSN 0036-8512
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COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH (CSIR)

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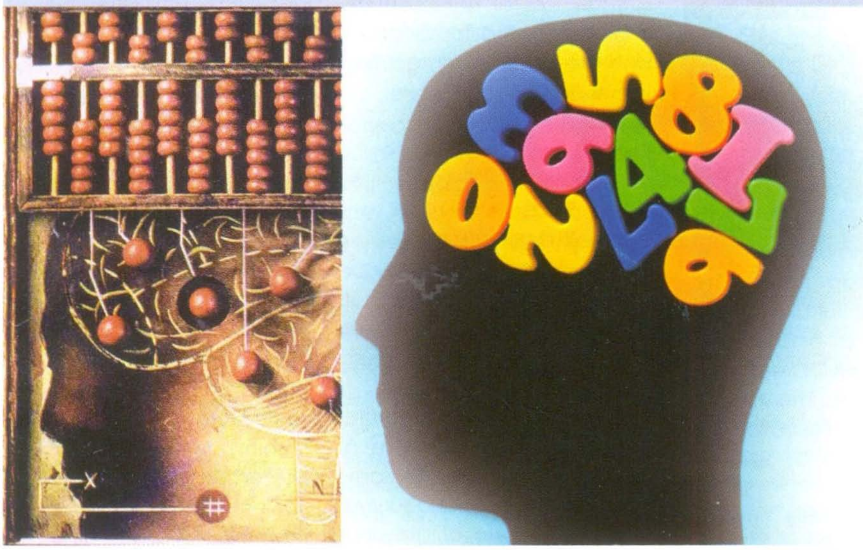

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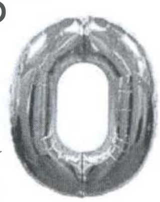

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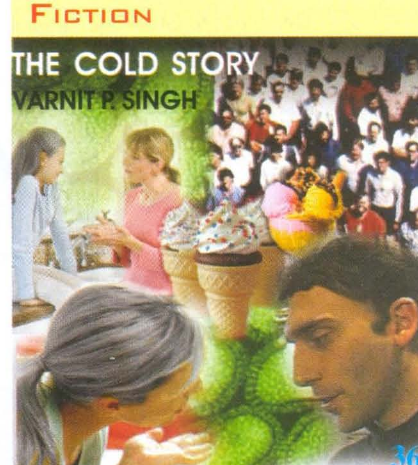
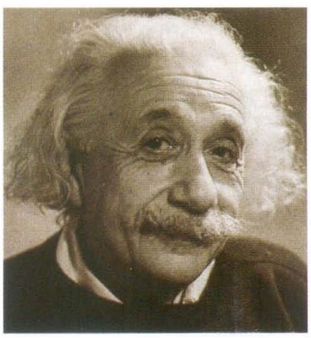


Science Reporter

Einstein and Gandhi

P. R. Vaidya in **Einstein: A Consistent Scientist, Inconsistent Man** has brought out a lesser known fact about Einstein, which shows the scientist in a rather bad light (January 2012). We are generally accustomed to treat



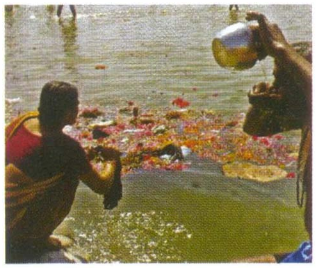
iconic figures with awe and reverence but from their follies and foibles we learn that they are just human beings.

The author has concluded that Gandhi's commitment was from the heart while that of Einstein was from the head. This reminds me of what Einstein had to say about the Mahatma: "A few centuries from now people will scarcely believe that a man like Gandhi walked in flesh and blood on the earth." I am not too sure what Gandhi had to say or said about the scientist. But surely Einstein's plea for making 'extremely powerful bomb of a new type' would not have gone well with a person committed to non-violence.

Dr. S.K. Gurtu
Mansarovar, Jaipur

Pathetic River

Congratulations for a very graphic article on the river Yamuna in the February 2012 issue of *Science Reporter*.



The author's remark that the water is unfit for drinking, bathing, washing clothes and unfit even for agriculture is really pathetic as the river flows right across our capital city. The suggestions for future action are also commendable.

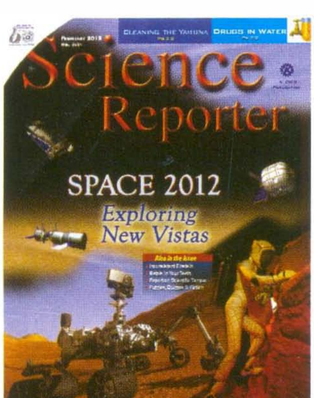
In Baroda (Vadodara, Gujarat) city, BARC has been operating a radioactive Cobalt-40 plant for treating the sewage water. The treated water is sold for irrigation and the mud cake as fertilizer profitably.

Lion P. Nukaiah Chetty
District Chairman: Water Management
Lions Clubs International
Anakapalle, AP

Basic Inputs

I have been a regular subscriber of *Science Reporter* and enjoy reading it very much. It is full of useful information, especially about life sciences. I would like to request you for regular inclusions of basic sciences articles in every issue of this magazine. I wish that each issue should contain at least one article about Physics, Chemistry, Mathematics, Zoology and Botany apart from the articles regularly appearing. If possible, applied sciences articles hitherto not appearing may also be regularly included. My wish is that this magazine should soon become an exhaustive and complete science magazine to be referred to for all scientific information and for all those who are interested in gaining knowledge about science.

Susheel. S
Kerala



Elevating Scientific Literacy

Kudos to *Science Reporter* for its well thought-out editorial **Gauging Scientific Literacy** in its November 2011 issue.

Promoting scientific literacy is very much a democratic need. For any nation to compete and survive in today's world of growing technological setting and influence, its people must be equipped with the perception of different scientific developments that touch one and all and the nation as a whole. There lies the importance of gauging the count of scientific literacy which has been aptly detailed in your esteemed editorial.

Ashoke Datta
Assam

Focus on Women

The January 2012 issue was indeed marvelous devoted as it was to accomplishments of women scientists.

Women in Space by Rakesh Shukla was an eye-opener article as it talked about the exploits of several women who have been able to conquer space, like Valentina Tereshkova, Shannon Lucid, Sunita Williams etc. The other significant article was **Female Stars in the Galaxy of Science** by S.G. Seetharam. Marie Curie indeed brought laurels to the entire woman community by winning two Nobel prizes. Women had to struggle long to get entry into the realms of science before the 18th Century.

The government of India's Department of Science & Technology has recently launched a new scheme to include more women in S&T. It must be remembered that when we educate a man we educate an individual, but when we educate a woman we educate the entire society.

Prof Prakash Manikpure
Nagpur

Write to Us

You are welcome to send any comments about any article published in *Science Reporter*, or share some information with our readers. Write to us at:

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Or send an Email at sr@niscair.res.in

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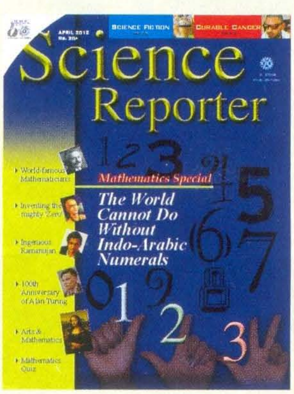
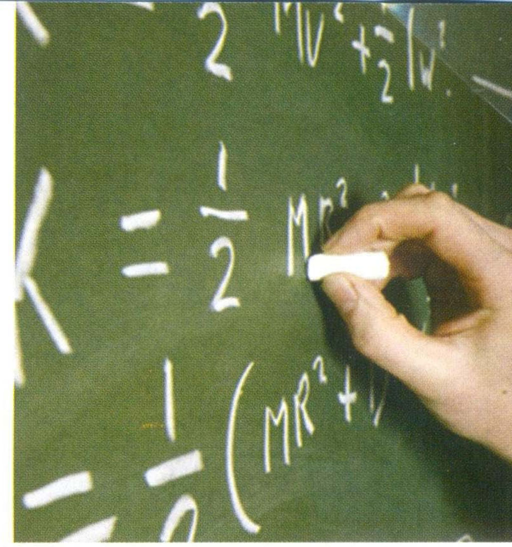


MATHS CAN BE FUN



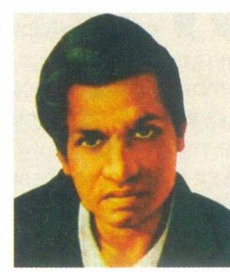
What do you do when faced with a tricky mathematical calculation? Many of us freeze. Out on a trip with friends when the time comes to calculate the complicated expenses, it becomes a painstaking exercise, and often we throw up our hands saying "I'm not good at maths." That is, if you are not one of those who are mathematically inclined.

Simple additions, subtractions, multiplications and divisions come easily. Geometry is, in a manner of speaking, interesting. But move on to equations, calculus and integration and the going gets tough. Many of those who find Mathematics imbued with a sense of 'fear factor' end up with the notion that if they are unable to understand Mathematics it is because of their own fault or perhaps because they lack a certain analytical bent of mind. Some believe that there is a 'maths gene' that makes some people naturally good at maths.

However, there is a view that the general fear of mathematics owes a great deal to how the subject is taught in our schools. Teaching methods often do not take into account the manner in which learning happens. John Mighton, the founder of 'Jump Math', a nonprofit organization whose maths curriculum is in use in Canadian and US classrooms serving 65,000 children from grades one through eight, and almost 20,000 children at home, says, "Math is like a ladder. If you miss a step, sometimes you can't go on. And then you start losing your confidence." Mathematics is also a subject that requires extensive practice to gain mastery.

Today's information age has reinforced the importance of mathematics as never before. The information explosion has thrown up statistical challenges and problem solving skills are highly prized by employers today. It is in this context that maths education in the country needs to be augmented.

In the land of the mathematics wizard Srinivasa Ramanujan the inadequate number of competent mathematicians is now being viewed with concern. Prime Minister Manmohan Singh recently voiced this concern at a function where he declared 2012 as the 'National Mathematical Year' as a tribute to Srinivasa Ramanujan whose 125th birth anniversary was celebrated on 22 December 2011. The PM also declared 22 December as the 'National Mathematics Day'. He said that the perception that pursuit of mathematics does not lead to attractive career possibilities "must change". Today there are many more career opportunities available for talented mathematicians.



Several efforts are underway to create a roadmap for national-level initiatives to celebrate 2012 as the National Year of Mathematics. The National Council of Educational Research and Training (NCERT) hopes to launch a series of activities to popularize mathematics in the country. These would include workshops for teachers and students for understanding abstract concepts in mathematics through experimentation, quiz, and poetry.

The Ramanujan Mathematical Society (RMS) has also planned a series of mathematical activities through the year 2012 for which a National Committee has been constituted with Minister for Human Resource Development Kapil Sibal as the chair. Other major projects that could be initiated include the establishment of a mathematics museum in Chennai (to be named after Ramanujan) and a documentary film on the history of Indian mathematics.

Hasan Jawaid Khan

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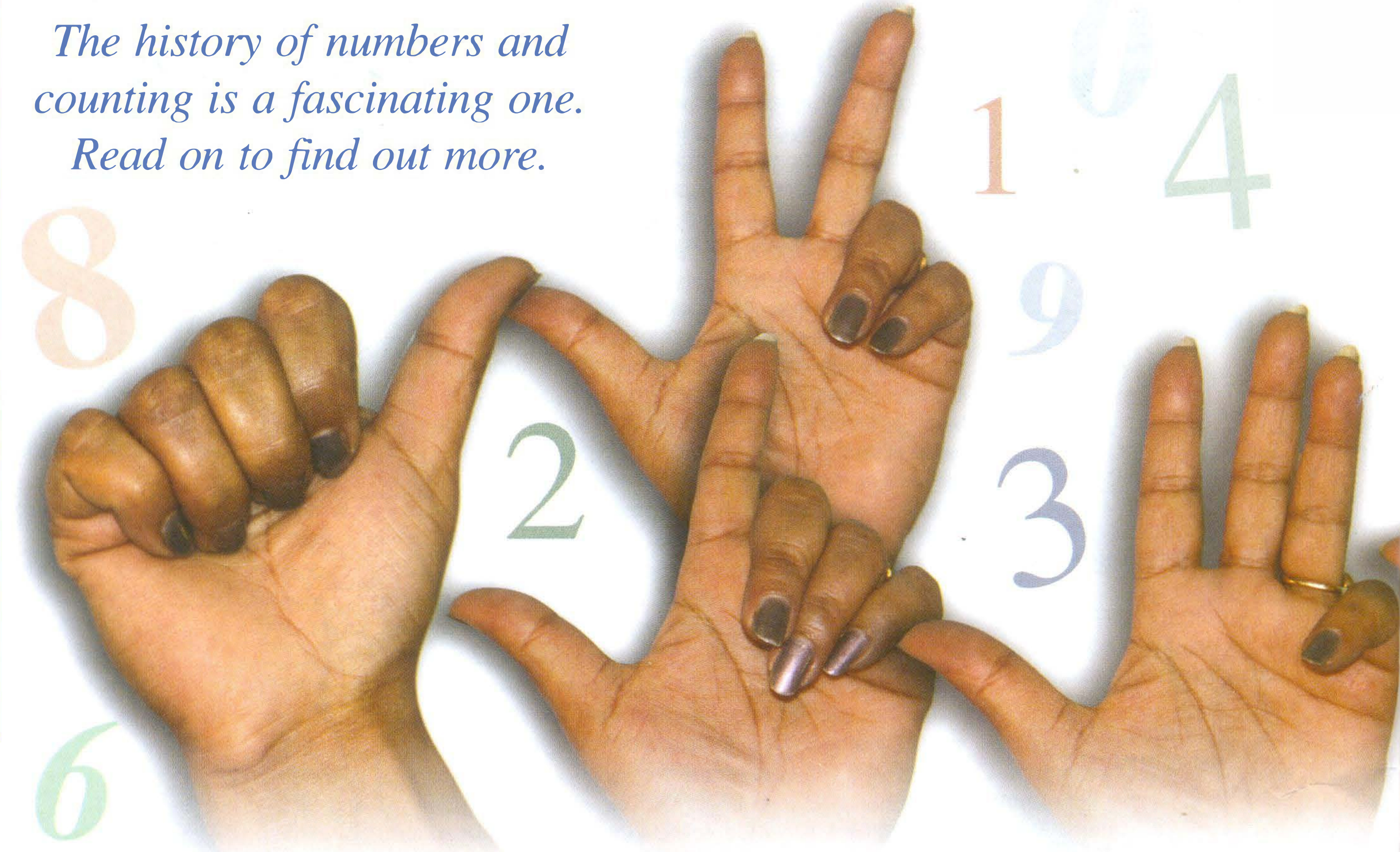
The history of numbers and counting is a fascinating one. Read on to find out more.

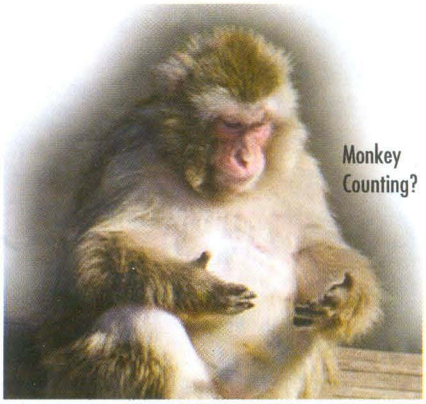


WALK in to a supermarket in China, even though the hoardings would be unintelligible, the numbers on the currency and coins and the telephone numbers would be easily readable. Take a stroll in the marketplace at Barcelona, the market babble wafting around you might be incomprehensible, but the price tags are easy to read. Walk into any remote region in Africa and you find that the written numbers – numerals – make sense, even though we cannot make head or tail of their scripts and languages.

The world over, counting styles are different, languages are varied, scripts are distinct, but numeral symbols 0,1,2,3,4,5,6,7,8,9 are easily recognizable everywhere. The Indo-Arabic numerals have hegemonized the world. It is as if the world speaks in various languages and writes in a number of scripts, but works in only one kind of number symbols. Ubiquity of Indo-Arabic numerals is more than obvious.

Number Sense

It is not as if numbers have been there all though the human history. Munduruku, indigenous hunter-gatherers in the Brazilian Amazon, have no words for numbers beyond five in their language while Piraha, another tribal community, do not have any name for numbers beyond three. But, they have a sense of numbers – they can discriminate between a heap having more than the other even though they may not count one by one.



Monkey Counting?

People of the Munduruku tribe have no words for numbers beyond five

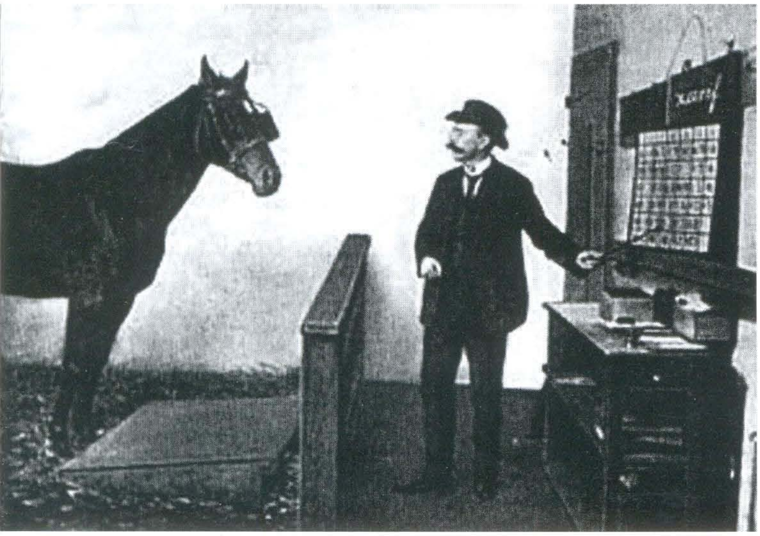
T.V. VENKATESWARAN

Ubiquitous Indo Arabic Numerals

Not just humans, it appears that animals also have, albeit primitive, a number sense. An eighteenth century anecdote aptly summarizes the number sense observed in the animal world. A nobleman wanted to shoot down a crow that had built its nest atop a tower on his domain. However, whenever he approached the tower, the bird flew out of gun range, and waited until the man departed. As soon as he left, it returned to its nest. The man decided to ask a neighbour for help. The two hunters entered the tower together and later only one of them came out. The nobleman thought he could deceive the crow, but the crow did not fall into this trap and carefully waited for the second man to come out before returning. Neither did three, four, or five men fool the clever bird. Each time, the crow would wait until all the hunters had departed. Eventually, the hunters came as a party of six. When five of them had left the tower, the bird, not so numerate after all, confidently came back, and was shot down by the sixth hunter!

Scientists have been sceptical of claims of mathematical abilities in animals ever since the case of "Clever Hans", a horse that is said to have responded to questions requiring mathematical calculations by tapping his hoof, but later revealed to be a case of subtle manipulation by the handler. As Ray Hyman puts it, "Hans was responding to a simple, involuntary postural adjustment by the questioner, which was his cue to start tapping, and an unconscious, almost imperceptible head movement, which was his cue to stop."

Nevertheless, subsequent experiments have revealed an



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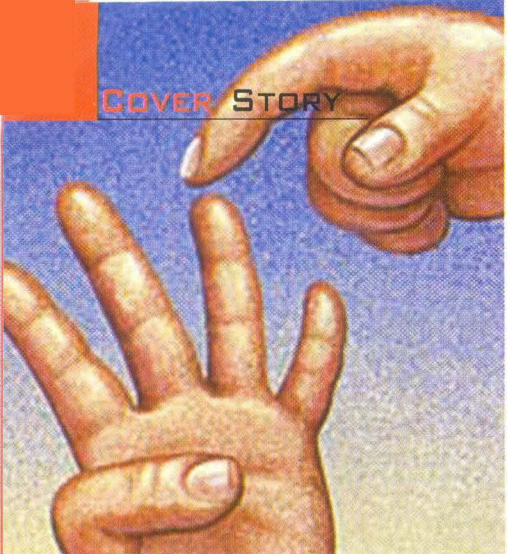
Bone with tally marks found in Ishango, a village in Africa



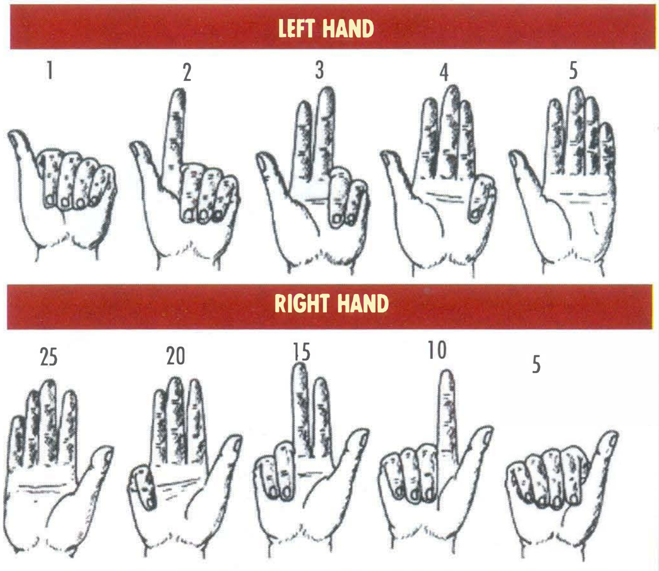
unexpected capacity for 'quantity discrimination' in animals as varied as bees, salamanders, rats, dolphins and primates, suggesting that mathematical abilities could be more fundamental in biology than previously thought. Trained monkeys can, it seems, perform rudimentary maths – they can compare two heaps of dots and identify which one has more.

Number sense, though not strictly in the sense of counting, could be important for animals to survive in the wild. If a chimpanzee is unable to look up a tree and quantify the amount of ripe fruit most likely it would go hungry. If a lion wants to attack another pack of lions it has to make a judgment how many are in each side. If a grazer is unable to judge the relative abundance of food in two patches, perhaps it would die of hunger. Evolutionary psychologists posit that such evolutionary pressures, perhaps, have led to evolution of sophisticated procedures for number sense in animals. Not surprisingly, primates and human toddlers too exhibit this primitive number sense.

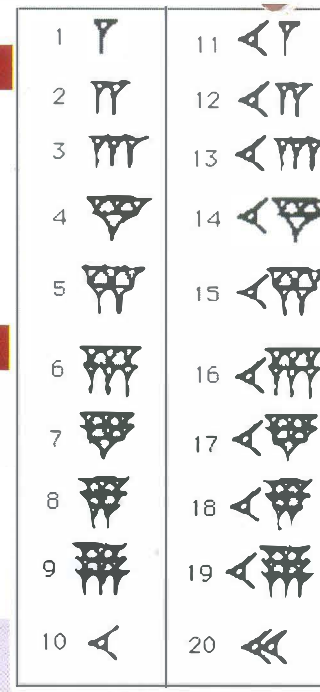
Birth of Counting

When Karl Absolon, a Czech archaeologist, discovered a wolf bone in the dust and debris of a 30,000-year-old Stone Age settlement, it became an instant sensation, so much so that the *London Illustrated News*, a weekly tabloid printed in London, carried its picture in its 2 October 1937 issue. This bone fragment discovered at Dolni Vestonice, a Palaeolithic site, is touted to be one of the earliest evidences that Stone Age mammoth hunters counted something – said to be the dawn of mathematics.

The bone had fifty-five little 'tally' notches carefully carved and they were arranged into groups of five. An additional long notch of double length separated the first twenty-five marks from the rest. It was clear that the carving and grouping were deliberate human action of counting something; perhaps the number of spears they had or the mammoths that they had hunted in the season, rather than mere scribble.



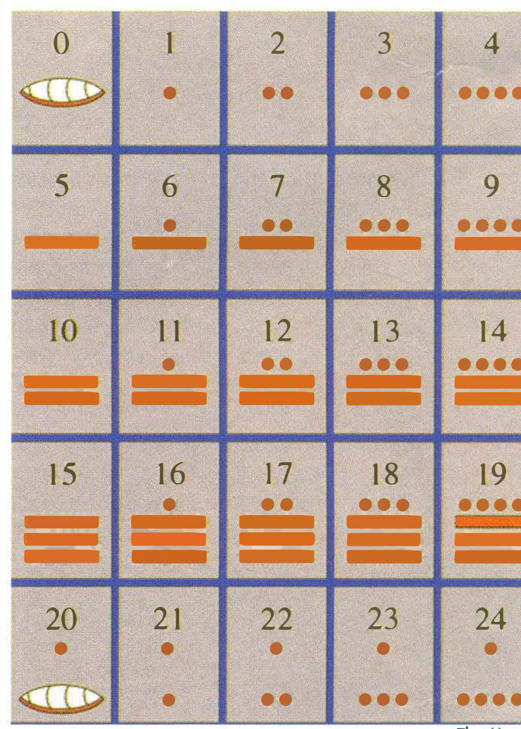
Counting on fingers



Babylonian counting

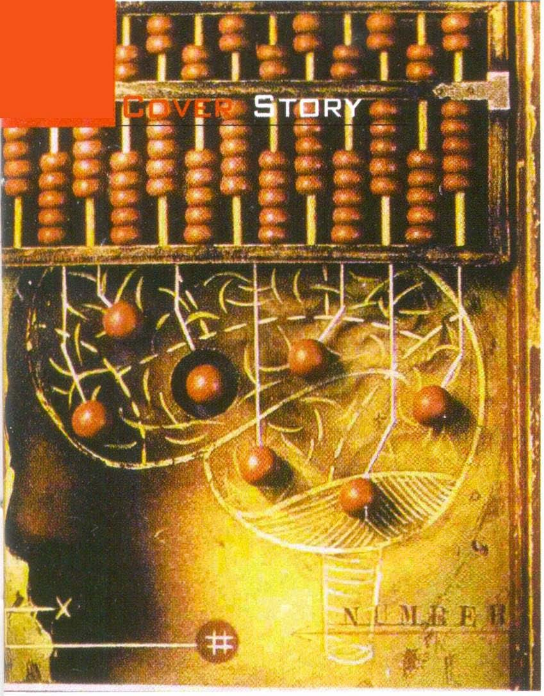
This is not an isolated case. Soon tally marks such as Lebombo bone, a piece of baboon fibula, found in the caves of Lebombo Mountains in Swaziland, dated to be 35,000 years old, with 29 notches were found. A similar bone with 29 notches, and about 18000 years old, has been discovered in Nicobar in India. Archaeologists interpret it as the counting of the cycle of waxing and waning of the moon or perhaps menstrual period.

At a fundamental level, these archaeological artefacts attest that early humans were counting rather than merely making an estimate and the pattern recognition had evolved into counting. Further, whatever that they were counting was important enough for them to warrant the keeping of records. Every notch, called tally mark, precisely represented something that they counted, implying a rudimentary version of an important mathematical cognition – the one-to-one correspondence between elements of two different sets of objects, or cardinality of numbers, in this case between the set of notches on the bone and the set of whatever the prehistoric humans were counting.

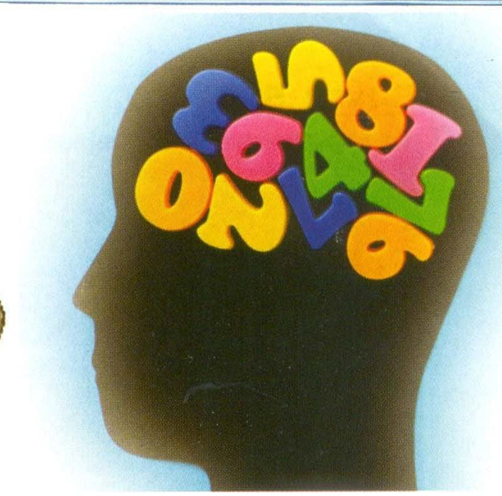


The Mayan system of counting

Not all such tally sticks excavated so far had just a few dreary lines carved on them. Ishango bone, a tiny 10 cm curved bone excavated at the Semliki River in Zaire dated to about 20,000 years old, is a significant find. The three rows of notched columns engraved on it are clearly patterned and two of them add up to 60. Also one of these two rows is grouped in to 11,13,17,19 – all prime numbers between ten and twenty. The third row has a particular pattern: 3 followed by its



Counting tokens in stone



With the scientific revolution setting in Europe, fetters fell and soon Indo-Arabic numerals became the only form to be used.

double, then 4, followed by its double, then 10, followed by its half, and indicates more sophisticated arithmetical reasoning.

Variety of Counting Systems

The bunching of lines into fives by the Dolni Vestonice Stone Age people perhaps is an indication of the primitive attempt at development of quinary counting system. You count five fingers in one hand and group them. Now six can be said to be 'one hand and one', seven 'one hand and two', thirteen becomes two hands and three, and so on. Many tribal dialects have such quinary counting number names, including Niam Niam dialect of Central Africa.

Tally is, in fact, the simplest numeral system, unary numeral system, in which every natural number is represented by a corresponding number of symbols. To write thirteen in this system you will have to carve lines thirteen times, which is indeed laborious.

Scholars speculate that using ten fingers of both hands for counting resulted in base ten – that is, decimal counting system. In many languages, including Tamil and Chinese, number names are clearly base ten; 15 is spoken as "ten five" and 57 as "five ten seven". On the other hand, many European systems of number words are irregular up to 100. For example in French, 92 is said as "four twenty twelve," corresponding to 4*20 + 12.

But quinary counting is not universal, nor counting upon ten fingers. Comparative studies have shown that counting of fingers, excluding the thumb, is also an established practice among some North American aboriginal tribes and thus numbers are grouped into fours instead of five – that is, quaternary counting. Archaeologists contend that one of the ancient Indian numerals, Gandharan Kharosthi numerals, are partially quaternary – base 4 – counting.

The Ndom language of Papua New Guinea is reported to be senary – that is base 6. The Yuki Tribes in Americas count the space between the fingers and have evolved an octal-base 8-number system. Consider the four fingers of your left hand: ignoring the thumb. The joints divide each finger into three parts; using the thumb as a pointer we can count up to 12 resulting in the dozanal counting.

Variations in terms of which parts of a hand people count with and to what other body parts they extend counting are evident. An ethno-mathematical study of merchants from Maharashtra indicates that they use five fingers in one hand to count from one to five and the fingers on the other to keep tab of multiplies of five. Body counting systems of Highland New Guinea such as the Oksapmin counting system make use of additional parts like the wrist, elbow, shoulder, head and so on counting up to 27.

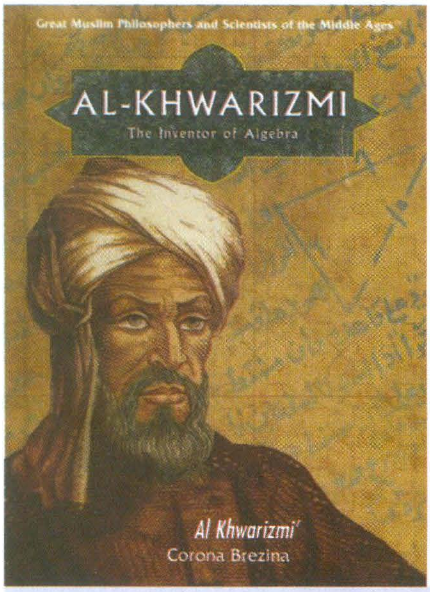
Mayans had a vigesimal, that is base 20, number system, so were the Dzongkha, of Bhutan and Munda, a tribal community in India. Roman system is bi-quinary, that is part base 5, part base 10. Roman number symbols go like this: I, II, III and IIII (in olden times they did not use IV for four). Then five has a unique symbol V. Now it is VI, VII, VIII, IX and X. Ten also has a unique symbol. In like manner, fifty is L and hundred is C, five hundred is D and thousand is M.

Of particular interest is the counting system of Siriona Indians of Bolivia and the Brazilian Yanoama. Their counting goes like "one," "two," "two and one," "two and two," "two and two and one," and so forth, very similar to what mathematicians would call binary counting. Similarly, in Australian Aboriginal language, Kala Lagaw Ya, the numbers one through six are *urapon, ukasar, ukasar-urapon, ukasar-ukasar, ukasar-ukasar-urapon, ukasar-ukasar-ukasar*. But why two? We are yet to fathom.

Hundreds and thousands of cuneiform records have been excavated from the ancient Sumer region, presently in Iraq. In these written records preserved in clay, there are symbols only for 1, 10, 60 and 3600, suggesting that the ancient Sumerians used sexagesimal – base sixty – number system. But why 60, and not 10 (fingers), or 20 (fingers and toes), or 5 (fingers on one hand)?

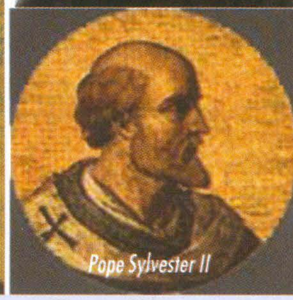
Sixty seems like an odd choice. Perhaps, Sumerians chose sixty for it has so many divisors. It can be divided by 2, 3, 4, 5, 6, 10, 12, 15, 20 and 30. This makes it easier when one is doing fractions and mental arithmetic. Another theory speculates that Sumerians counted to 60 using both hands like we do but with a difference: they used finger segments instead of whole fingers. Take your left hand and exclude the thumb finger. In the rest four fingers there are 12 segments. Now instead of using the left thumb to point, we can use the five fingers of the right hand as pointers. Now, 12 x 5 = 60.

The Babylonians, who made great advances in mathematics and astronomy, embraced the Sumerian sexagesimal base. Though Egyptians and later Greeks based their number system on ten, for measuring time or computing angle they continued to use the Babylonian sexagesimal method. This is why today we

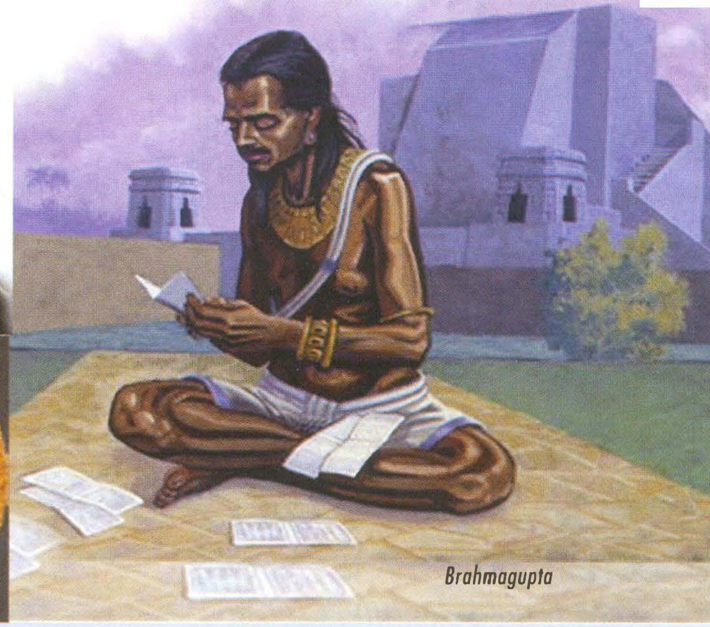


Al Khwarizmi

Fibonacci



Pope Sylvester II



Brahmagupta

In 825 AD, Al Khwarizmi wrote a book "Calculations with Hindu Numerals" (Ketab Fi Istimal al adad al-hind). This book made the Indian system popular in the Arab world. The significance of this system was realized by Fibonacci, a European scholar, who learnt the Indian numeral system from the Arabs. Back in 967 CE, for example, the monk who became Pope Sylvester II figured out that the counting would be easier with a zero sign. Pope Silvester II was hounded for his advocacy of zero. Zero was a bizarre number. Brahmagupta found that zero multiplied by any number is zero; zero added or subtracted from any number makes no difference.

have 360 degrees of a circle and 60 seconds in a minute and 60 minutes in an hour. In fact, it should be noted that in ancient India the time was not counted in base 60 units. In ancient India, one day was divided into 30 *muhuratas*. Each *muhurat* was 2 *nadikas* or 30 *kalas*.

Surely two plus two is four; no one can say it is not, whatever base we use. Mathematical truths cannot be influenced by culture or ideology. However, our approach to mathematics is very much influenced by culture.

Numerals – Alphabets of Numbers

Scribbling lines for each count is laborious. Soon people found that there was an easy way to write numbers. Archaeologists claim that even before writing became prolific, number systems had already been well established. Transcribing the oral number system into written form was a simple task: people just needed to figure out a coding method whereby scribes could set the numbers down in a more permanent form.

In one of the earliest numerals, Egyptian, pictures stood for numbers; a single vertical mark representing a unit, a heel bone representing 10, a coiled rope representing 100, a lotus representing 1000 and so on. To write down a number, say 123, with this scheme, all an Egyptian scribe had to do was write just six symbols – coiled rope for hundred; two heal bones for twenty and three vertical marks for unit three rather than carve one hundred and twenty three times tally marks.

Mayans had just three symbols: zero (shell shape), one (a dot) and five (a bar). For example, nineteen (19) is written as four dots in a horizontal row above three horizontal lines stacked one upon the other.

Enthralment of European traders and scholars at the simple and concise Indo-Arabic numerals is captured elegantly in a woodcut printed in Margarita Philosophica published in 1503. "Arithmetica", the deity of mathematics, is shown watching a competition between an "abacist", one who uses Roman numerals for computation, and an "algorist", one who uses Indo-Arabic numerals.

ROMAN NUMBERS

I = One

V = Five

X = Ten

L = Fifty

C = Hundred

D = Five hundred

M = Thousand

The world over, counting styles are different, languages are varied, scripts are distinct, but numeral symbols 0,1,2,3,4,5,6,7,8,9 are easily recognizable everywhere. The Indo-Arabic numerals have hegemonized the world.

On the other hand the Babylonian sexagesimal system required fifty-nine distinct symbols. A vertical wedge represented 1, and a fat horizontal one represented 10. Suppose you wanted to write sixty-three. Then what do you do? Sixty-three is sixty + three. So you combine the symbol for sixty and symbols for three: Now seventy is actually 60+10. This is actually 60x1+10. So you take the symbol for 1 and symbol for 10 and write it as . Should we try writing 124 in the Babylonian system? 124 is actually 2x60+4; so you take the symbol for '2' and the symbol for '4' and write them as. Can you try writing 2012 in the Babylonian system?

The Babylonian system is what mathematicians would call as the place value system. What does '2' in '245' in modern number system denote? It is not just two. It is actually 2 x 100, that is, two hundred. Similarly, '4' in 245 is actually 4 x 10, that is, forty. The notation '2' has a value depending upon the place it holds in the string of symbols. The notation '2' in this system could be just two, or twenty or two hundred depending on the 'position' it occupies. In like manner, the Babylonian number system was also a place value system. The notation for three in Babylonian system could mean just three, or one hundred and eighty (3x 60) or 1080 (3x60x60) depending upon the place it holds.

Traditional Chinese numerals are also a place value system. In decimal place value system, from right to left the value of the symbol increases as 1, 10, 100 etc and in Mayan vigesimal it increases as 1 , 20, 400, 8000 and so on; in sexagesimal the place value would be 1, 60, 360, 10800 and so on. In contrast, Roman numerals, which had their lineage in the Egyptian numerals, are not a place value system. C, for example, is 100, irrespective of the place it holds in the string of roman numerals; thus, CLXXX is 180, and MMDCCXXV is 2725.

From Counting to Numbers

Discovered in the village of Bakhshali (now in Pakistan), a catch of birch bark manuscript written in Gatha dialect, mixture of Sanskrit and Prakrit, is one of the oldest Indian mathematical texts found so far. Dated to be as old as 200 CE, the manuscript provides evidence of the use of just ten symbols for writing any number, use of zero and negative numbers in Indian mathematics.

The Greeks, like the Romans, inherited their mathematics from Egyptians, and had no place for either zero or negative numbers. For ancient Egyptians, tilling the land in the flood plains of the Nile was the most profitable venture. Each household thus had a specific parcel of land assigned to them and delineated by boundary markers. Come the next flood, the boundary markers were washed away or damaged. Therefore, pharaohs assigned surveyors to assess the land area and reset the boundary markers, after every flood; thus geometry was born. These surveyors understood that one could determine the area of a plot of land by dividing it into rectangles and triangles. Further, Egyptian mathematicians also learnt to measure the volumes of objects like pyramids.

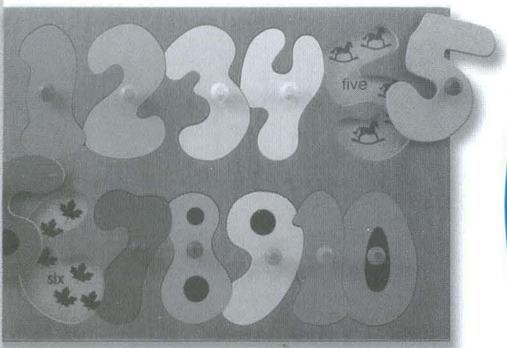
Length defined the number for Greek mathematicians. When a surveyor placed the measuring rod on the ground, the 'interval' between the edge to the point marked 'one' represented one unit. Thus, all numbers were just multiples of the measuring rod. Multiplication and division made sense when computing the areas and volumes; you had a plot of land 3 feet wide and 4 feet long, then the area of the plot was 3 x 4 that is 12 square feet.

Thus, Egyptians and later Greeks imagined squares in square numbers and the areas of rectangles when they multiplied two different values. So, numbers were linked to geometry. Lengths, areas, and volumes resulting from geometrical constructions – all numbers had to be positive; hence there was no place for negative numbers. Obviously, lines with zero length, plot of land with zero area or a cone with zero volume were unreal and hence zero had no place in their configuration of things.

Unlike the Greeks, the Indian system viewed numbers stripped of their geometric significance and hence did not worry whether the mathematical operations made any geometric sense. You cannot subtract four acres of land from three acres of land; but you can do an algebraic sum three minus four and get –1 (negative number) as a legitimate *mathematical* answer. If your thoughts are fettered by geometric notions, then negative numbers obviously make no sense. But to ancient Indian mathematicians unencumbered by geometric notions, negative numbers made perfect sense.

This was the birth of what we now know as algebra. This mindset had a significant import. Indians could embrace zero and negative numbers without any hesitation. Indeed, it was in India (and in China) that negative numbers first appeared. Brahmagupta, an Indian mathematician of the seventh century, alluded to positive and negative numbers as 'profits' and 'losses'. He also gave rules for doing arithmetic with negative numbers. He said, "Positive divided by positive, or negative by negative, is positive, Positive divided by negative is negative, Negative divided by positive is negative" – arithmetic rules that we recognize today.

Zero as a place holder is a requirement in any positional number system, unlike the non-positional Roman numerals. The complex and sophisticated sexagesimal (base-60) positional numeral system of the Babylonian mathematics showed a gap in between the numerals to indicate absence of positional value (or zero); later a punctuation symbol (indicated by two slant wedges) was used to fill the gap.



0

What is $0 \div 0$ and $1 \div 0$? Today, we just banish this question by saying it is 'inde-terminate'.

In Indo-Arabic numerals, in order to express the number 206, a symbol is needed to show that there are no tens. The digit 0 serves this purpose. Mayans also had a symbol for zero, a seashell, much before Indian numerals. But these are just zero as place holder; a punctuation mark – not zero the concept or zero the number.

Just as three minus four was now a number (negative number), three minus three could also be construed as a number – zero. Since zero was equal to 3–3, then it had to be placed between positive one (2 – 1) and negative one (2 – 3). Nothing else made sense. No longer could zero sit next to nine, just as it does in mobile telephone keyboards; zero had a distinct position in the number line. This was a crucial breakthrough in mathematical thinking. The famous mathematician Alfred North Whitehead noted, "The point about zero is that we do not need to use it in the operations of daily life. No one goes out to buy zero fish. It is in a way the most civilized of all the cardinals, and its use is only forced on us by the needs of cultivated modes of thought."

However, zero was a bizarre number. Brahmagupta found that zero multiplied by any number is zero; zero added or subtracted from any number makes no difference. But what is $0 \div 0$ and $1 \div 0$? Brahmagupta and others were foxed. Today, we just banish this question by saying it is 'indeterminate'.

Indian Numerals Go Places

Today, the world over we use ten with specific unique symbols for numbers: 0 1 2 3 4 5 6 7 8 9. The shapes of the numbers were unlike the modern 1, 2, etc, but this ingenious method for writing numbers just by using ten symbols was invented in India thousands of years ago. After the number nine comes ten written as 10. Notice that 10 is not a distinct symbol; it is a combination of two unique symbols. In similar manner, all numbers are written by various combinations of these ten symbols.

India and Arabia have had trade and interaction from times immemorial. Arabian travellers and traders learnt the Indian system of numbers and found it easier than Roman or Greek numerals. In 825 AD, Al Khwarizmi wrote a book "Calculations with Hindu Numerals" (*Ketab Fi Istimal al adad ai-hind*). This book made the Indian system popular in the Arab world.

The significance of this system was realized by Fibonacci, a European scholar, who learnt the Indian numeral system from the Arabs. He strongly advocated the use of Indo-Arabic numerals in his book Liber Abaci in 1202 and showed that complex computations could be made using Indo-Arabic numerals without recourse to the 'calculator'.

Roman numerals were cumbersome and unwieldy for making longhand calculations. Imagine trying to multiply the following: MDCCLXVII (times) LVI or (1767 x 56). Do not even think about trying to perform Long Division using Roman Numerals! With Indo-Arabic numerals one can do all the four basic arithmetical operations just with pencil and paper. You have a simple algorithm, however boring it may have been when we learnt it in the first place.

Enthralment of European traders and scholars at the simple and concise Indo-Arabic numerals is captured elegantly in a woodcut printed in *Margarita Philosophica* published in 1503. "Arithmetica", the deity of mathematics, is shown watching a competition between an "abacist", one who uses Roman numerals for computation, and an "algorist", one who uses Indo-Arabic numerals. Judging from the clothes of the two competitors, the abacist is a monk and the algorist a worldly scholar. Arithmetica appears to favour the algorist; her own clothes are covered in Indian numerals, and she looks approvingly at the algorist's progress marking the triumph and the final acceptance of Indo-Arabic numerals in Europe.

Nevertheless, the spread of Indo-Arabic numerals in Europe was not smooth. Fibonacci's book appeared during the period of the Crusades against Islam, and the clergy was suspicious of anything with Arab connotations. Some, in fact, considered the new arithmetic the Devil's work precisely because it was so ingenious – Indo-Arabic numerals were banned and prohibited. Zero in particular was an obstacle; even Fibonacci referred to the "nine [Indian numerals] and the sign 0". This suspicion led to a series of actions against zero.

Back in 967 CE, for example, the monk who became Pope Sylvester II figured out that the counting would be easier with a zero sign. He was accused of hobnobbing with evil spirits and forced to abjure it. In 1299, Florence city authorities banned the use of Indo-Arabic numbers and in 1348 the ecclesiastical authorities of Padua issued prohibition against the use of zero. The fear of Indo-Arabic numerals is revealed through the etymology of some modern words. *Sunya* was translated as *sifr* – meaning void in Arabic, which was transliterated as *zephirum* in Latin. The Portuguese derivative word *chifre*, meant '[Devil] horns', and the English word cipher, meant 'secret code'.

This did not inhibit the practical minded European merchants or progressive scholars, who just went ahead using Indo-Arabic numerals with Zero because it was so much easier. However, when Church authorities unreasonably put restrictions the bankers simply created duplicate sets of books, one to show the church, one to do calculations in.

With the scientific revolution setting in Europe, fetters fell and soon Indo-Arabic numerals became the only form to be used. Through European colonialism Indo Arabic numerals went to different parts of the world and today the Roman numerals are seen only on the clock faces, numbering of prefaces in books and the like.

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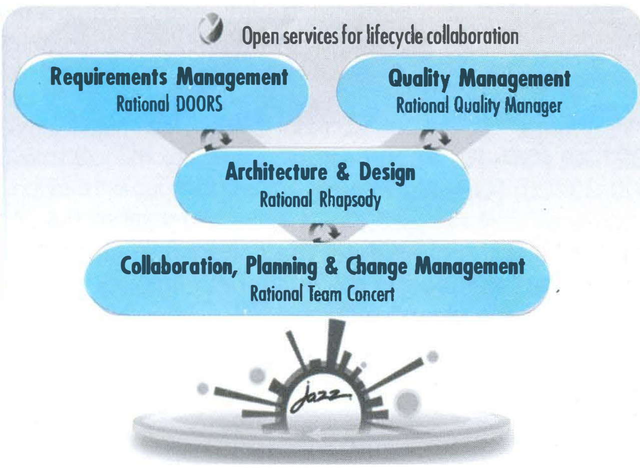
Software Development is Now Much Easier

IBM has recently launched a new platform known as "Jazz.net in which all the modeling, designing coding and testing tools are provided on a single platform. No need to use different tools to develop different parts of the same application. In Jazz.net all the tools work hand-in-hand. It also keeps a record of the past activities related to the projects done prior to the current project.



The various components being provided by the Jazz platform are:

Rational Team Concert: Helps you pick your team. Team members can be selected on the basis of their eligibility, educational background, experience or even on the basis of location. Members can work either by sitting next to each other or from remote locations too. The work done by the members can also be assessed.

Rational Rhapsody & Rhapsody Design Manager: This tool helps designing of the desired project with related attributes as per the client specifications. Requirement about the product lifecycle is also validated using this tool.

Rational DOORS: This tool takes care of all the requirements regarding the project. The operations manager can keep a check on the operations being performed and the requirements needed to complete the operation.

Rational Quality Manager: The tool helps achieve design quality by applying various type of testing and also tells the desired ways in which the best can come out.

According to IBM, the new platform helps transform the designing, development and delivery to create more innovative products and services, at lower costs and reduced risk.

Contributed by Mr Nitin Kumar Ahir, Research Intern, NISCAIR

Optimal Foraging Strategy

Writing in the journal *Physical Review Letters*, Dr Rainer Klages from Queen Mary's School of Mathematical Sciences, Professor Lars Chittka from the School of Biological and Chemical Sciences, and their teams, describe how they carried out a statistical analysis of the velocities of foraging bumblebees. They found that bumblebees respond to the presence of predators in a much more intricate way than was previously thought.

Bumblebees visit flowers to collect nectar, often visiting multiple flowers in a single patch. There is an ongoing debate as to whether they employ an 'optimal foraging strategy', and what such a theory may look like.

'Invisibility' Cloak could Protect Buildings from Earthquakes

University of Manchester mathematicians have developed the theory for a Harry Potter style 'cloaking' device that could protect buildings from earthquakes.

Dr William Parnell's team in the University's School of Mathematics have been working on the theory of invisibility cloaks, which until recently, have been merely the subject of science fiction. In recent times, however, scientists have been getting close to achieving 'cloaking' in a variety of contexts. The work from the team at Manchester focuses on the theory of cloaking devices, which could eventually help to protect buildings and structures from vibrations and natural disasters such as earthquakes.

Writing in the *Proceedings of the Royal Society A*, Dr Parnell has shown that by cloaking components of structures with pressurised rubber, powerful waves such as those produced by an earthquake would not 'see' the building – they would simply pass around the structure and thus prevent serious damage or destruction. The building, or important components within it, could theoretically be 'cloaked'.

This 'invisibility' could prove to be of great significance in safeguarding key structures such as nuclear power plants, electric pylons and government offices from destruction from natural or terrorist attacks.

This is one of the latest 'cloaking' technologies to be developed – a technique which makes an object near-invisible to waves whether they be light, sound or vibration.

The scientists have shown theoretically that pre-stressing a naturally available material – rubber – leads to a cloaking effect from a specific type of elastic wave. The team is now working on more general theories and to understand how this theory can be realised in practice.

Dr Klages explains: In mathematical theory we treat a bumblebee as a randomly moving object hitting randomly distributed targets. However, bumblebees in the wild are under the constant risk of predators, such as spiders, so the question we wanted to answer is how such a threat might modify their foraging behaviour.

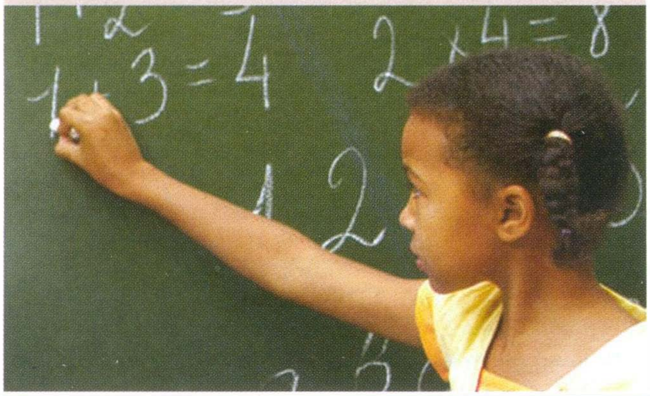
The team used experiments that track real bumblebees visiting replenishing nectar sources under threat from artificial spiders, which can be simulated with a trapping mechanism that grabs the bumblebee for two seconds. They found that, in the absence of the spiders, the bumblebees foraged more systematically and travelled directly from flower to flower. When predators were present, however, the bumblebees turned around more often highlighting a more careful approach to avoid the spiders.

Girls' Verbal Skills Make Them Better at Arithmetic

While boys generally do better than girls in science and math, some studies have found that girls do better in arithmetic. A new study published in *Psychological Science*, a journal of the Association for Psychological Science, finds that the advantage comes from girls' superior verbal skills. Zhou and his colleagues did a series of tests with children ages 8 to 11 at 12 primary schools in and around Beijing. Indeed, girls outperformed boys in many math skills.

They were better at arithmetic, including tasks like simple subtraction and complex multiplication. Girls were also better at numerosity comparison – making a quick estimate of which of two arrays had more dots in it. Girls outperformed boys at quickly recognizing the larger of two numbers and at completing a series of numbers (like 2 4 6 8).

Boys performed better at mentally rotating three-dimensional images. Girls were also better at judging whether two words rhymed, and Zhou and his colleagues think this is the key to their better math performance. Counting is verbal; the multiplication table is memorized verbally, and when people are doing multiple-digit calculations, they hold the intermediate results in their memory as words.



Modeling Drugs

Richard Braatz from MIT, applies mathematics to streamline the development of pharmaceuticals. Trained as an applied mathematician, Braatz is developing mathematical models to help scientists quickly and accurately design processes for manufacturing drug compounds with desired characteristics.

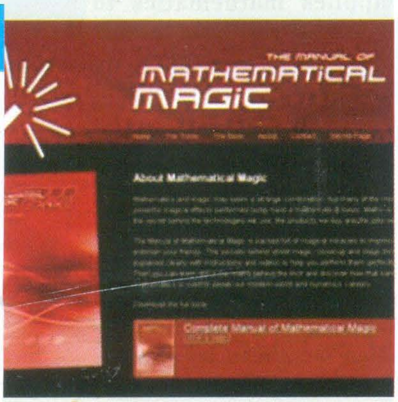
Through mathematical simulations, Braatz has designed a system that significantly speeds the design of drug-manufacturing processes; he is now looking to apply the same mathematical approach to designing new biomaterials and nanoscale devices.

Over the years, Braatz learned that while drug-manufacturing machinery was often monitored by sensors, much of the resulting data went unanalyzed. He pored over the sensors' data, and developed mathematical models to gain an understanding of what the sensors reveal about each aspect of the drug-crystallization process. His team devised an integrated series of algorithms that combined efficiently designed experiments with mathematical models to yield a desired crystal size from a given drug solution. They worked the algorithms into a system that automatically adjusts settings at each phase of the manufacturing process to produce an optimal crystal size, based on a recipe given by the algorithms.

The automated system, which has since been adopted by Merck and other pharmaceutical companies, provides a big improvement in efficiency, avoiding the time-consuming trial-and-error approach many drug manufacturers had relied on to design a crystallization process for a new drug.

PUTTING THE MAGIC INTO MATHS

Queen Mary, University of London has developed a new educational resource for teachers to help students use amazing magic tricks to learn about maths. The web resource (www.mathematicalmagic.com), which includes the 'Manual for Mathematical Magic' and a series of interactive videos, shows how maths and magic can fuse together education and entertainment.

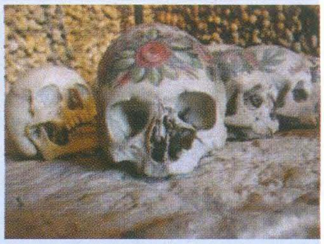


While most tricks have been explained, there are included a few that the viewer is left to figure out. The educational website builds on a bank of teaching resources including Illusioneering (www.Illusioneering.org), a website which gives students and teachers the platform to explore science and engineering through a range of magic tricks; and cs4fn (www.cs4fn.org), a web and magazine initiative putting the fun into computer science.

NEWS BRIEFS

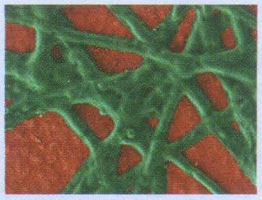
■ Scientists have produced a theory for a quantum-cloning machine able to produce several copies of the state of a particle at atomic or sub-atomic scale, or quantum state. Quantum cloning is difficult because quantum mechanics laws only allow for an approximate copy – not an exact copy – of an original quantum state to be made, as measuring such a state prior to its cloning would alter it. In this study, researchers have demonstrated that it is theoretically possible to create four approximate copies of an initial quantum state, in a process called asymmetric cloning.

■ Scientists have discovered a missing link between the body's biological clock and sugar metabolism system, a finding that may help avoid the serious side effects of drugs used for treating asthma, allergies and arthritis. The proteins that control the body's biological rhythms, known as cryptochromes, interact with metabolic switches that are targeted by certain anti-inflammatory drugs. The finding suggests that side effects of current drugs might be avoided by considering patients' biological rhythms when administering drugs, or by developing new drugs that target the cryptochromes.



■ Scientists studying a unique collection of human skulls have shown that changes to the skull shape thought to have occurred independently through separate evolutionary events may have actually precipitated each other. Researchers examined 390 skulls from the Austrian town of Hallstatt and found evidence that the human skull is highly integrated, meaning variation in one part of the skull is linked to changes throughout the skull. The Austrian skulls are part of a famous collection kept in the Hallstatt Catholic Church ossuary.

■ An increase or decrease in your blood pressure during middle age can significantly impact your lifetime risk for cardiovascular disease (CVD), according to a research. Researchers found people who maintained or reduced their blood pressure to normal levels by age 55 had the lowest lifetime risk for CVD (between 22 percent to 41 percent risk). In contrast, those who had already developed high blood pressure by age 55 had a higher lifetime risk (between 42 percent to 69 percent risk).



■ Photosynthesis is considered the "Holy Grail" in the field of sustainable energy generation because it directly converts solar energy into storable fuel using nothing but water and carbon dioxide. Scientists have long tried to mimic the underlying natural processes and to optimize them for energy device applications such as photo-electrochemical cells (PEC), which use sunlight to electrochemically split water and thus directly generate hydrogen, cutting short the more conventional approach using photovoltaic cells for the electrolysis of water.

■ When a plant encounters drought, it does its best to cope with this stress by activating a set of protein molecules called receptors. These receptors, once activated, turn on processes that help the plant survive the stress. A team of plant cell biologists has discovered how to rewire this cellular machinery to heighten the plants' stress response – a finding that can be used to engineer crops to give them a better shot at surviving and displaying increased yield under drought conditions.

■ For the first time, the presence of large-bodied herbivorous dinosaurs in Antarctica has been recorded. Until now, remains of sauropoda – one of the most diverse and geographically widespread species of herbivorous dinosaurs – had been recovered from all continental landmasses, except Antarctica. Identification of the remains of the sauropod dinosaur suggests that advanced titanosaurs (plant-eating, sauropod dinosaurs) achieved a global distribution at least by the Late Cretaceous.

RINTU NATH

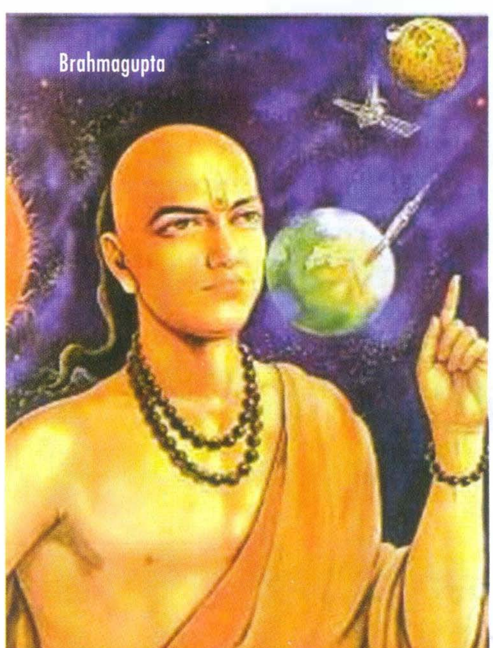
The Mighty Zero

Zero is a tiny number, but never ignore it. Without zero, not just mathematics, but all branches of sciences would have struggled for clearer definitions.

ZERO is a strange number and one of the great paradoxes of human thought. It means both nothing and everything. The concept of zero, first formulated by the Indian mathematician Brahmagupta around AD 628, is the most important discovery in the history of mathematics.

Initially, zero was not considered a number. There was the idea of empty space, which may be thought conceptually similar to zero. Babylonians around 700 BC used three hooks to denote an empty place in the positional notation. Almost during the same time, Greek mathematicians made some unique contributions to mathematics. Euclid wrote a book on number theory named *Elements*, but that was completely based on geometry and no concept of zero was mentioned.

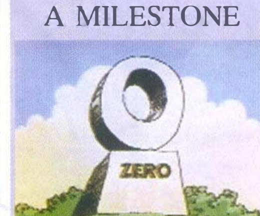
Around AD 650, the use of zero as a number came into Indian mathematics. The Indians used a place-value system and zero was used to denote an empty place. In fact there is evidence of an empty placeholder in positional numbers from as early as AD 200 in India. Around AD 500 Aryabhata devised a number system, which had no zero, as a positional system, but used to denote empty space. There is evidence that a dot had been used in earlier Indian manuscripts to denote an empty place in positional notation. For example, to represent '100' it would be two dots after 1.



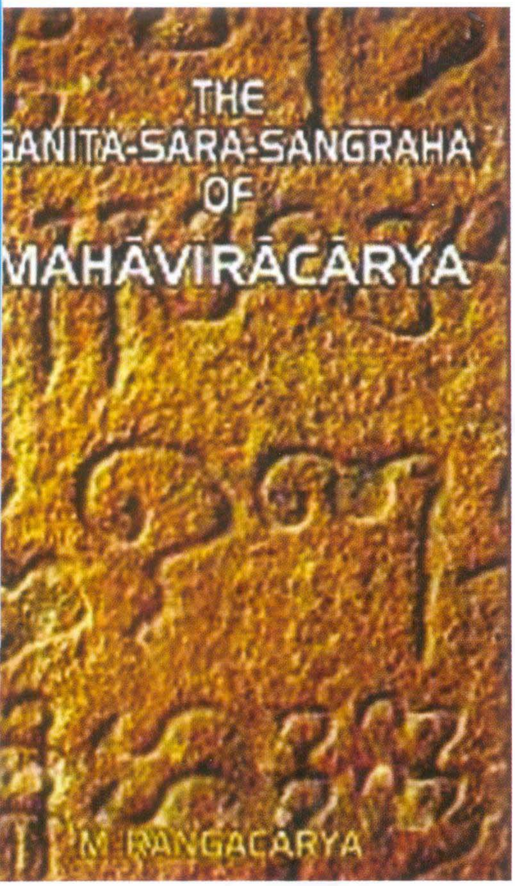
In AD 628, Brahmagupta wrote *Brahmasphutasiddhanta* (The Opening of the Universe), and attempted to give the rules for arithmetic involving zero and negative numbers. He explained that given a number, if you subtract it from itself you obtain zero. He gave the following rules for additions involving zero: *The sum of zero and a negative number is negative, the sum of a positive number and zero is positive; the sum of zero and zero is zero.* Similarly, he gave the correct rules for subtraction also.

Brahmagupta then said that any number when multiplied by zero is zero but when it comes to division by zero, he gave some rules that were not

A MILESTONE



'Zero' the ingenuity of our fore-fathers.



correct. However, it was an excellent attempt to visualise the number system in the light of negative numbers, zero and positive numbers.

In AD 830, another Indian mathematician Mahavira wrote *Ganita Sara Samgraha* (Collections of

Bhaskara did correctly state other properties of zero, such as square of zero is zero and square root of zero is also zero.

Mathematics Briefings), which was designed as an update of Brahmagupta's book. He correctly stated the multiplication rules for zero, but again gave incorrect rule for division by zero.

After 500 years of Brahmagupta, mathematician Bhaskara tried to solve the problem of division by stating that any number divided by zero is infinity. Well, conceptually though it is still incorrect, Bhaskara did correctly state other properties of zero, such as square of zero is zero and square root of zero is also zero.

It is therefore clear that Indian mathematicians developed the concept of zero and stated different mathematical operations involved with zero. But how did the concept spread around the world?

From India to the World

The Islamic and Arabic mathematicians took the ideas of the Indian mathematicians further west. Al-Khwarizmi described the Indian place-value system of numerals based on zero and other numerals. Ibn Ezra, in the 12th century, wrote *The Book of the Number*, which spread the concepts of the Indian numeral symbols and decimal fractions to Europe.

In 1247, the Chinese mathematician Ch'in Chiu-Shao wrote *Mathematical Treatise in Nine Sections* in which he used the symbol '0' for zero. In 1303, Chu Shih-Chieh wrote *Jade Mirror of the Four Elements*, which again used the symbol '0' for zero.

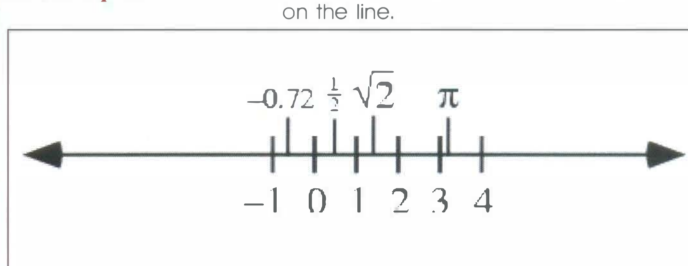
Around 1200, Leonardo Fibonacci wrote *Liber Abaci* where he described the nine Indian symbols together with the sign '0'. However, the concept of *zero* took some time for acceptance. It was only around 1600 that *zero* began to come into widespread use after encountering a lot of support and also criticism from mathematicians of the world. That is how *shunyam* given by our forefathers was recognised in the world and made its place permanently as *zero*.

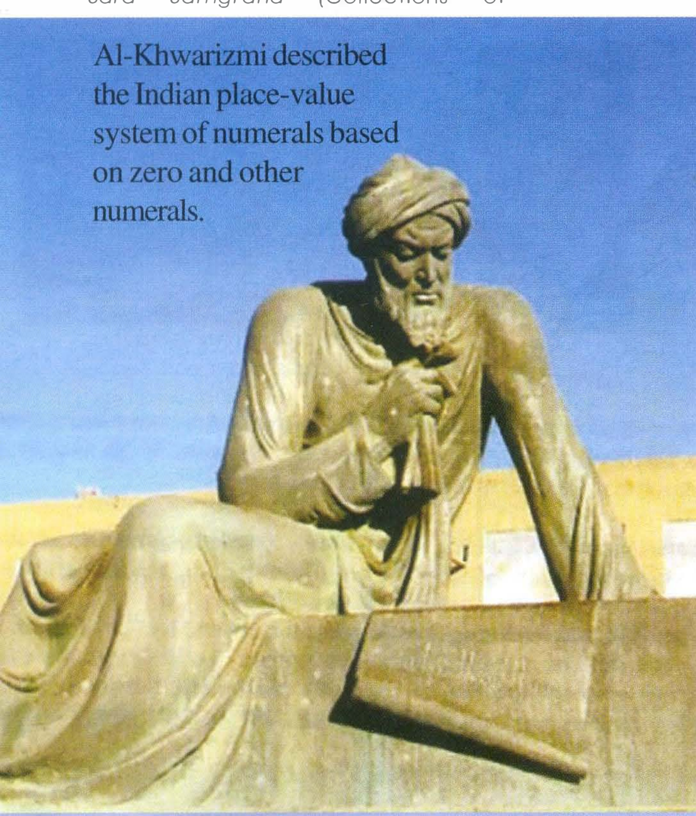
Interestingly, the word *zero* probably came from the Sanskrit word for *shunyam* or the Hindi equivalent of *shunya*. The word *shunyam* was translated to Arabic as *al-sifer*. Fibonacci mentioned it as *cifra* from which we have obtained our present *cipher*, meaning empty space. From this original Italian word or from the alteration of Medieval Latin *zephirum*, the present word *zero* might have originated.

Unique Number

The number 0 is neither positive nor negative and appears in the middle of a number line. It is neither a prime number nor a composite number. It cannot be a prime because it has an infinite number of factors and cannot be composite because it cannot be expressed by multiplying prime numbers (0 must always be one of the factors).

Real numbers include all rational (i.e., numbers that can be expressed as *p/q*, like 2) and irrational numbers (that cannot be expressed as fraction, like "2). Now all these real numbers can be placed uniquely in a real line towards both positive and negative direction. Hence all positive, negative, even, odd, rational and irrational numbers correspond to only a single point on the line.





Al-Khwarizmi described the Indian place-value system of numerals based on zero and other numerals.

Ibn Ezra, in the 12th century, wrote The Book of the Number, which spread the concepts of the Indian numeral symbols and decimal fractions to Europe.

Undefined: In mathematics, an expression is said to be *undefined* when it does not have meaning and so is not assigned an interpretation. For example, division by zero is *undefined* in the field of real numbers.

Indeterminate: A mathematical expression is said to be *indeterminate* if it is not definitively or precisely determined. Certain expressions of limits are termed as *indeterminate* in limit theorem. There are seven indeterminate forms involving 0, 1 and infinity (“).

(0 / 0), 0 . “, (“ / “), (“ - “), 0^0, “^{0}, 1“

Zero free: An integer value whose digits contain no zeros is said to be *zero free*. For example, square of 334 is a *zero free* square. In recent times, a lot of interesting work is going on to find the *zero free* number for *n*th power.

Mighty Naught: The power of zero is sequenced in the following expression. The number in each power indicates the number of zeros that should follow after 1. For example, 10^6 means that 1 is followed by 6 zeros. The definition mentioned here is the American system of counting. So start counting your zeros now:

10^2	=	*Hundred*
10^3	=	*Thousand*
10^6	=	*Million*
10^9	=	*Billion*
10^{12}	=	*Trillion*
10^{15}	=	*Quadrillion*
10^{18}	=	*Quintillion*
10^{21}	=	*Sextillion*
10^{24}	=	*Septillion*
10^{27}	=	*Octillion*
10^{30}	=	*Nontillion*
10^{33}	=	*Decillion*
10^{36}	=	*Undecillion*
10^{39}	=	*Duodecillion*
10^{42}	=	*Tredecillion*
10^{45}	=	*Quattuordecillion*
10^{48}	=	*Quidecillion*
10^{51}	=	*Sexdecillion*
10^{54}	=	*Septendecillion*
10^{57}	=	*Octadecillion*
10^{60}	=	*Novemdecillion*
10^{63}	=	*Vigintillion*
10^{100}	=	*Googol*
10^{Googol}	=	*Googolplex*

Zero is a tiny number, but we should never ignore its might. Imagine the world without zero. Not only mathematics, but all branches of sciences would have struggled for more clear definitions had zero not existed in our number system.

Among these real numbers, zero has the most important and unique position. It lies in the intersection between positive and negative numbers. If one goes to the right side from zero, the numbers are positive and if one goes towards the left side of zero, we have negative numbers. So essentially zero is neither positive nor negative number, it is the borderline for positive and negative numbers, or it is neutral in that sense. In fact, this is the only number in the real number world, which is neither positive nor negative.

Zero as a single entity has no power of its own. If you put zero on the left side of any number, the number still remains powerless. But if you start adding it to the right side of a number, zero starts exhibiting its power and the number increases by ten times for each additional zero.

Division by Zero

If zero is added to a positive or a negative number, then you remain in the same number point in the real line scale, i.e., there is no change in the value. And if you multiply any positive or negative real number with zero, the result is zero.

However, division by zero is tricky. Brahmagupta himself could not describe the operation properly and later Bhaskara also mentioned it incorrectly. According to him, if any number is divided by zero, the answer is infinity.

At first instance, assigning a very high value or the value of infinity to the result of the division of some positive number by zero seems logical. For example, if one continues to divide a real positive number by a smaller number, the result will go on increasing. For example,

10/10	=1
10/1	=10
10/0.01	=1000
10/0.0001	=10,0000
$10/10^{-99} = 10^{100}$	
	and so on ...

Therefore, as you keep dividing by a smaller number and go towards zero, the value of the result increases. But still the smaller number is not equal to zero. Therefore, one is not actually doing any division by zero, rather predicting a trend, which might be possible if the divisor reaches a value closer to zero. But whatever the smallest number one may think of, another number smaller than that would exist.

Moreover, it is to be understood that infinity is a concept, an abstract thing, not a number as defined in our number system and all rules of mathematics are invalid while one considers operation with infinity. For example, if infinity is added to infinity, the result is not twice the value of infinity. It is still infinity!

It is therefore wrong to say that a number divided by zero is infinity. In fact, in the very first place it is wrong to attempt to divide a number by zero.

Let us understand the situation.

A division is essentially the inverse of multiplication. That means if you divide 10 by 2, you get 5. And if you multiply 5 with 2, you get your original value back again. Through algebra, we can put it like this:

If $(a / b) = c$, then $a = (b \times c)$

Let's see what happens when we follow the infinity theory. Assume that $a = 10$ and $b = 0$. Now, if you attempt to do (a / b) and assume c = infinity, then according to the rule of multiplication, we get 10 = (0 × infinity). But the rule of multiplication for zero says that anything multiplied with zero is zero. That means applying the multiplication rule would give us finally 10 = 0. So we cannot get back 10 by multiplying the elements on the right hand side, rather we get some absurd result as above while attempting and evaluating something divided by zero.

The uniqueness of division breaks down when we attempt to divide any number by zero because we cannot recover the original number by inverting the process of multiplication. And zero is the only number with this property. So division by zero is *undefined* for real numbers. So we should

Around AD 500 Aryabhata devised a number system, which had no zero, as a positional system, but used to denote empty space. There is evidence that a dot had been used in earlier Indian manuscripts to denote an empty place in positional notation.

For example, to represent '100' it would be two dots after 1.

never attempt to do a division with zero…it is meaningless. This is the reason why in all computer programs or mathematical calculations, one needs to take care of this vital operation and there needs to be an appropriate strategy to deal with such a situation.

Indeterminate

Another interesting case is zero divided by zero. Mathematically speaking, an expression like zero divided by zero is defined as *indeterminate*. To put it simply, this is a sort of expression that cannot be determined accurately. If we look at the expression properly, we cannot assign any value to it. That means (0/0) can be equal to 10, 100, or anything else and interestingly the rule of multiplication also holds true here since 10 or 100 multiplied by zero will give the product as zero. So the basic problem is that we cannot determine the exact or precise value for this expression. That is why mathematically (0/0) is said to be *indeterminate*.

Zero to the power zero is also *indeterminate*. Mathematically, this situation is similar to zero divided by zero. Using limit theorem, it can be found that as *x and a tend to zero*, the function a^x takes values between 0 and 1. So zero to the power zero is also termed as *indeterminate*. But modern day mathematicians are giving many new theories and insights regarding proper explanation of zero to the power zero. Some mathematicians say that accepting $0^0 = 1$ allows some formulas to be expressed simply while some others point out that $0^0 = 0$ makes life easier. So this expression is not as naïve as it looks like!

Factorial of Zero

The factorial of zero is equal to one. This is because the number of permutations one can do with zero elements is only one. This also can be proved mathematically. Remember here that the factorial of one is also one.

Zero is a tiny number, but we should never ignore its might. Imagine the world without zero. Not only mathematics, but all branches of sciences would have struggled for more clear definitions had zero not existed in our number system. Numbers from 2 to 9 are absent in the binary system, and so are numbers 8 and 9 in the octal system. However, zero is everywhere and it is one of the significant discoveries of mankind. Thanks to the ingenuity of our forefathers.

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BIKRAM KESHARI JENA

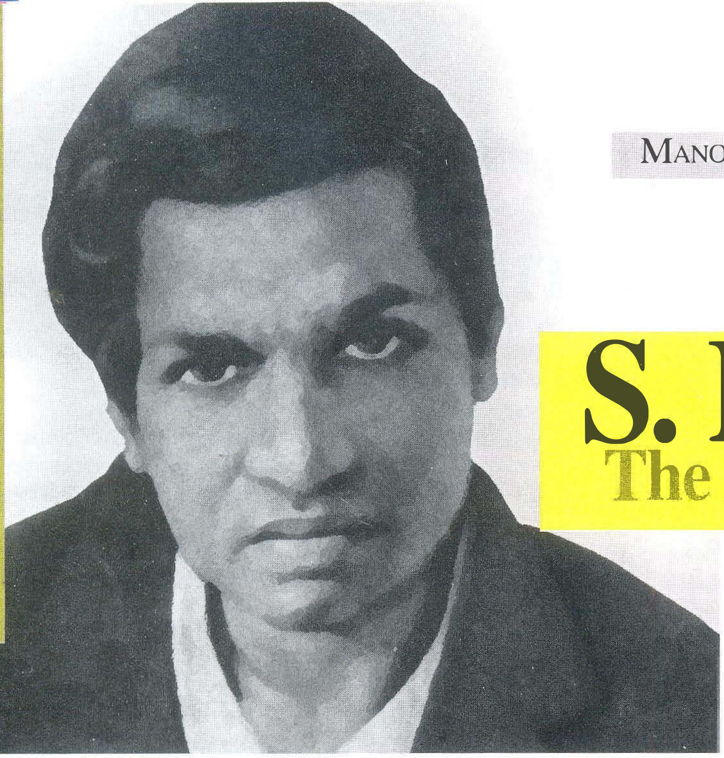
MOMENTS OF MATHEMATICS

1. **Which branch of Mathematics is called "Pebbles" in Latin?**
   a. Trigonometry b. Geometry
   c. Calculus d. Statistics
2. **What is the Ramanujan Number?**
   a. 1729 b. 1331
   c. 1927 c. 1111
3. **Which Indian mathematician is credited with inventing 0 (zero)?**
   a. Aryabhatta b. Bhaskar
   c. Chanakya d. Brahmagupta
4. **A Hollywood movie depicts the life and work of a mathematician named John Nash played by Russell Crowe. Name the film.**
   a. The Beach b. A Beautiful Mind
   c. Life is beautiful d. Piano
5. **Which 12th century Indian mathematician propounded the concept of infinity in his work Bija Ganita?**
   a. Bhaskara b. Brahmagupta
   c. Aryabhatta d. Varahamihira
6. **Which geometrical figure is known as "Witch of Agnesi"?**
   a. Straight line b. Point
   c. Curve d. Angle
7. **Name the mathematician who is credited with publishing the highest number of research papers on mathematics?**
   a. Euler b. Libnitz
   c. Paul Erdos d. Isaac Newton
8. **Whose image is engraved on the obverse of the Fields Medal, one of the greatest prizes in the field of mathematics?**
   a. Newton b. Pythagoras
   c. Euler d. Archimedes
9. **According to legend, who discovered that musical notes could be translated into mathematical equations by watching a blacksmith's hammer?**
   a. Pythagoras b. Leibnitz
   c. Fermat d. Euclid
10. **The Elements, a famous book on mathematics was written by whom?**
    a. Leibnitz b. Euler
    c. Fermat d. Euclid
11. **Who developed the "polygonal number theorem" which states that each number is a sum of three triangular numbers, four square numbers, five pentagonal numbers and so on?**
    a. Fermat b. Pythagoras
    c. Euler d. Euclid
12. **Blaise Pascal and Pierre de Fermat are said to have jointly developed which part of mathematics?**
    a. Statistics b. Calculus
    c. Coordinate Geometry d. Theory of Probability
13. **Which mathematician invented the mechanical calculator named after him?**
    a. Fermat b. Pascal
    c. Euler d. Maria Agnesi
14. **S. R. Srinivasa Varadhan, is the first Indian to win which prestigious award in mathematics?**
    a. Fields Medal b. Abel Prize
    c. Chern Medal d. Wolf Prize
15. **Which famous mathematician published the book "Beat the Dealer", based on the gambling game Blackjack?**
    a. Paul Erdos b. John Fields
    c. Edward Thorp d. Srinivas Ramanujan
16. **Name this German mathematician who devoted a major part of his life in calculating the numerical value of "pi", which he published in his book "Van den Circkel" (On the Circle)?**
    a. Ludolph van Ceulen b. William Jones
    c. Archimedes d. Fermat
17. **This branch of mathematics is derived from an Arabic word meaning "Restoring What is Broken" and was originally applied to bone-setting as late as 17th century. Name it?**
    a. Geometry b. Trigonometry
    c. Algebra d. Statistics
18. **Which famous mathematician's tomb carried a sculpture illustrating his favorite mathematical proof, consisting of a sphere and a cylinder?**
    a. Cicero b. Pythagoras
    c. Euclid d. Archimedes
19. **The Mock Turtle in the "Alice in the Wonderland" has classified which branch of mathematics into four parts?**
    a. Trigonometry b. Arithmetic
    c. Algebra d. Geometry
20. **This mathematical constant was adopted as an abbreviation for the Greek word for "Perimeter" by William Jones in 1706. Name this much-used constant?**
    a. Pi b. Alpha
    c. Omega d. Beta

ANSWERS

1. c	2. a	3. a.	4. b	5. a	6. c	7. c	8. d
9. a	10. d	11. a	12. d	13. b	14. b.	15. c	16. a
17. c	18. d	19. b	20. a				

Contributed by Mr Bikram Keshari Jena, currently working as Welfare Extension Officer under the government of Orissa. Address: Khalipatana, Panchirida, Nayagarh, Orissa-752080; Email: bikramjena73@yahoo.com



MANORANJAN KUMAR SINGH & ANIKET RANJAN

S. Ramanujan
The Keats of Mathematics

Here's a look at the life of a genius, extremely short though it was

PLACING Ramanujan along side John Keats may seem a bit paradoxical – the former belonging to mathematics and the latter to English literature. Moreover Ramanujan has never been marked having an interest in literature nor in English language. But, the juxtaposition is apt and appropriate in the sense that both the heroes of respective faculties are the best examples of the proverb "Men live in deeds and not in years".

John Keats lived only for twenty-six years. In this short span of life granted to him, he dived deep into the ocean of literature and gave many precious verses that are peculiar and unique. He left an everlasting imprint on the body of English literature by devoting his life to the service of English literature. He lived through many odds in life. Miseries dominated his life. He died of Tuberculosis. He stands in no way less than the other (poets), some of whom were fortunate enough to spend even a century.

Likewise, Srinivasan Ramanujan lived only for thirty-three years. For him also, life was not a bed of roses – trials and tribulations became a part and parcel of his life. But he remained engrossed in his mathematical passion notching up several milestones in his short life span.

John Keats was in love with Fanny Browne who could not become his. Throughout his life the longing for his lady love did not proceed to fruition. Something of the same kind happened with Srinivasan who could not enjoy the company of his wife Janaki when he needed it so much and this perhaps is the sad reason why his health went on deteriorating both internally and externally leading to his final departure. Incidentally, both the geniuses fell victim to the same disease – tuberculosis.

The researches done and the formulas given by Srinivasan are of much significance without which mathematicians could not do in modern times. He was one of the greatest mathematicians of modern times. Ramanujan's life was a lesson in triumph and tragedy. By his profound and amazingly original work he has carved for himself a permanent place in the history of mathematics. Although he had little formal education, Ramanujan has left a memorable imprint on mathematical thought. He had no formal training in mathematics to speak of and was truly an untutored genius, an uncut diamond but of uncommon brilliance.

Early Life of a Prodigy

Srinivasa Ayyangar Ramanujan was born at Erode in the Madras Presidency on 22 December 1887 to Komalathmmal and K. Srinivasa Iyengar. He was a mathematical prodigy. During his school days, he impressed his teachers, senior students and classmates with his intuition and astounding proficiency in several branches of mathematics – algebra, trigonometry, arithmetic and number theory.

In later years, a friend of his recounted the following incident. In an arithmetic class on division, the teacher was explaining that if three bananas were given to three boys, each boy would get a banana. The teacher generalised this idea. Ramanujan is said to have asked: "Sir, if no banana is distributed to no student, will every one still get a banana?"

Another friend who took private tuitions from Ramanujan also recalled that Ramanujan used to ask about the value of zero divided by zero and then answer that it can be anything since the zero of the denominator may be several times the zero of the numerator and vice-versa and that the value cannot be determined. To this intriguing question Bhaskara proved the answer to be infinity.

In fact, the uncommon brilliance of Srinivasan in the subject may be marked by putting only one example of his adolescent stage when he was asked by a senior school student to find out the unknown quantities of the equation $x + y = 7$ and $x + \quad y = 11$ and Ramanujan solved it quickly and said that $x = 9$ and $y = 4$. At that time he was in the fourth year at school and such a question was expected to be tackled only by a sixth year student. This won for him a friend who in later years took him to the Collector of Nellore.

$x + y = 7$ ~ $x = 7 - y$
Squaring both the sides, we get
$x = (7\text{-}y)^2$
$x + y = 11$ ~ $y = 11 - x$
Again squaring both the sides, we have
$Y = (11 - x)^2$

Using the value of x from (i) in (ii), we get
$y = \{11 - (7 - y)^2\}^2$
$y = 121 + (7 - y)^4 - 2.11.(7 - y)^2$
$y = 121 + 2401 - 1372y + 294y^2 - 28y3 + y^4 - 22(49+y^2\text{-}14y)$
$y = 2522 - 1372y + 294y^2 - 28y^3 + y^4 - 1078 \text{-}22y^2 + 308y$
$y^4 - 28y^3 + 272y^2 - 1065y + 1444 = 0$
$y^4 - 4y^3 \text{-}24y^3 + 96y^2 + 176y^2 - 704y - 361y + 1555 = 0$
$y^3(y - 4) - 24y^2(y \text{-}4) + 176y(y \text{-}4) - 361(y \text{-}4) - 0$
$(y \text{-}4)(y^3 - 24y^2 + 176y \text{-}361) = 0$
$y - 4 = 0$ or $y^3 - 24y^2 + 176y - 361 = 0$
$y = 4$

Since $x + y = 11$
$x + 4 = 11$
$x + 2 = 11$ ~ $x = 9$

Thus x = 9 and y = 4 are the solutions of the given equations

Alternatively we have $x + y = 7$ (i)
And $x + y = 11$ (ii)
(ii) – (i)
$x + y - x - y = 11 \text{-}7$
$(x - y) + (y - x) = 4$
$\{(x)2 - (y)2\} + (y - x) = 4$
$(x + y)(x - y) - (x - y) = 4$
$(x - y)(x + y - 1) = 4$

Now the R. H. S of equation (iii) i.e 4 can be factorised as 2 x 2 : -2 x -2 , 4 x 1 ; -4 x -1. 1 x 4 and -1 x -4 respectively. And thus from equation (iii) we may get six equations.

CASE-I
If the R.H.S. of (iii) is 2 x 2, then we have
$x - y = 2$ and $x + y - 1 = 2$
viz. $x - y = 2$ and $x + y = 3$

On solving these two equations, we get
$2x = 5$ i.e. $x = 5/2$ ~ $x = 25/4$
And $y = 1/2$ ~ $y = 1/4$

Obviously the values of x and y do not satisfy the equation (i) and (ii)

CASE–II
If the R.H.S of (iii) is -2 x -2, then we get
"x - "y = -2 and "x + "y - 1 - -2
i.e. "x - "y = -2 and "x + "y = -1

On solving these two equations, we at once get
2"x = -3 ~ "x = 3/2 ~ x = 9/4
And 2"y = 1 ~ "y = 1/2 ~ y = 1/4

Again we find that these values do not satisfy the equation (i) and (ii)

CASE–III
When the R.H.S. of (iii) is 4 x 1, then we have
$x - y = 4$ and $x + y \text{-}1 = 1$
i.e. $x - y = 4$ and $x + y = 2$

On solving, we get
$2x = 6$ $x = 3$ $x = 9$
And $2y = \text{-}2$ $y = \text{-}1$ $y = 1$

Again these values of x and y do not satisfy the equation (i) and (ii).

CASE-IV
When the R.H.S of (iii) is -4 x -1, then we have
$x - y = \text{-}4$ and $x + y\text{-}1 = \text{-}1$
i.e. $x - y = \text{-}4$ and $x + y = 0$

On solving these pairs of equations, we get

$2x = \text{-}4$ $x = \text{-}2$ $x = 4$
And $2y = 4$ $y = 2$ $y = 4$

Again these pairs of values do not satisfy the equation (i) and (ii)

CASE-V
When the R.H.S. of (iii) is 1 x 4, we get
$x - y = 1$ and $x + y - 1 = 4$
i.e. $x - y = 1$ and $x + y = 5$

On solving these two equations, we get
$2x = 6$ $x = 3$ $x = 9$
And $2y = 4$ $y = 2$ $y = 4$

We find that these values of x and y satisfy the equation (i) and (ii).

CASE-VI
When the R.H.S of (iii) is -1 x -4, we have
$x - y = \text{-}1$ and $x + y - 1 = \text{-}4$
i.e. $x - y = \text{-}1$ and $x + y = \text{-}3$

On solving these two equations, we get
$2x = \text{-}4$ $x = \text{-}2$ $x = 4$
And $2y = \text{-}2$ $y = \text{-}1$ $y = 1$

Again these values of x and y do not satisfy the equation (i) and (ii).

In this way we observe that the only solution of equation (i) and (ii) can be obtained by CASE-V as $x = 3$ i.e. $x = 9$ and $y = 2$ i.e. $y = 4$.

The senior mathematics teacher of the school Ganapathy Subbier had such confidence in Ramanujan's ability that he even entrusted him the task of preparing for the school a conflict-free timetable.

In his fourth year at school, Ramanujan masterted *Loney's Trigonometry*, part II. In 1903, through his friends from the Kumbakonam Government College Ramanujan obtained G.S. Carr's *Synopsis*, a book on pure mathematics, containing propositions, formulae and methods of analysis with abridged demonstrations. It contained about 6000 formulae without proofs

Ramanujan used to ask about the value of zero divided by zero and then answer that it can be anything since the zero of the denominator may be several times the zero of the numerator and vice-versa

in geometry, algebra, trigonometry and Calculus. Through the new world thus opened to him, Ramanujan went bounding with delight. It was this book that awakened his genius. He set himself to establish the formulae given therein.

In 1904, from Town High School, Madras, Ramanujan passed his Matriculation Examination in the first class. This gained him the Subramanian Scholarship. He thus entered the Government College in Kumbakonam. He had to study English, Sanskrit, Mathematics, Physiology and History.

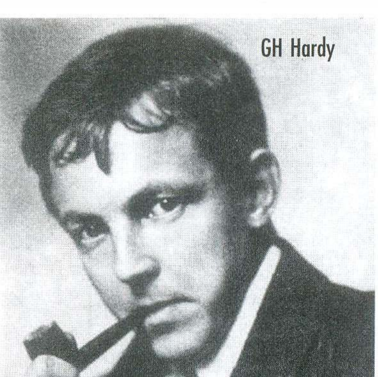
The urge to pursue mathematics became irrepressible in him. Topics such as magic squares, continued fractions, prime numbers, elliptic integrals and hyper-geometric series engaged his attention. His excessive devotion to mathematics resulted in his neglect of other subjects, and he failed in the F.A. examination in 1905 and was advised to continue his studies in some other college.

Subsequently, Ramanujan joined the F.A. class at Pachaiyappa's College, Madras in 1906. J.A. Yates, the Principal of the college at that time, recognized his abilities and gave him a scholarship. Ramanujan continued his mathematical activities with vigour. He could hardly study a few months at the college as his health was getting affected. When he fell ill he discontinued his studies and returned to Kumbakonam. Urged by his father he appeared as a private candidate for the F.A. examination in 1907 but failed. This marked the end of his formal education.

Years of Adversity

The years between 18 and 25 are the most critical years in a mathematician's career. During his five unfortunate years (1907-1912) Ramanujan's genius was misdirected, sidetracked and to a certain extent distorted, says Prof. G.H. Hardy. Despite the great financial difficulties he had, inspired by Carr's *Synopsis*, Ramanujan started noting down his own results in Notebooks.

A college mate of Ramanujan has stated that during the college years, Ramanujan taught him the method of constructing Magic Squares, the subject of the first chapter of his first and second notebooks, which dates from his school days.


GH Hardy

During his five unfortunate years (1907-1912) Ramanujan's genius was misdirected, sidetracked and to a certain extent distorted, says Prof. G.H. Hardy.

Ramanujan's investigation in continued fraction and divergent series started during this period. He had to do all this by discovering them *de novo*.

He recorded his results in his notebooks. Proofs were often absent. The profundity of contents of these notebooks as they are being analysed today reveal more and more staggering complexities. Intuition played a large part in these researches. There are three such notebooks in all containing 212, 352, and 33 pages respectively. Exact facsimiles of these notebooks have now, since 1957, been published in two volumes by the co-operative effort of the University of Madras, The Tata Institute of Fundamental Research and Sir Dorabji Trust.

It was during this period at the age of 22 that Ramanujan was married (betrothal) to Janaki, then 9 years old in 1909. The marriage took place near Karur. With the new responsibilities he was constantly in search of a benefactor and a job to earn enough to sustain his needs. He tutored a few students in mathematics first in Kumbakonam and later he sought employment as a tutor in mathematics to eke out a livelihood in Madras.

He had heard about Prof. V. Ramaswamy Iyer, the founder of the Indian Mathematical Society. Ramanujan approached him for help. Ramaswamy Iyer looked at some of the notebooks of Ramanujan. He was wonderstruck by the intricate theorems and the formulas contained in them. Assessing his plight, he gave a letter of recommendation to Prof. P.V. Seshu Iyer who got Ramanujan a temporary job of a clerk at the Accountant General's Office at Madras. He worked there for a few days but was not satisfied with the job. He came to know about a vacancy of a clerk in Madras Port Trust. He made a formal application and wrote to Prof. Seshu Iyer as well as to Ramachandra Rao, Collector of Nellore for their help. Ultimately he got the job as a clerk in the Madras Port Trust on a salary of Rs. 30/month.

Turning Point

Ramanujan's entry into the Port Trust in 1912 may well be considered as the turning point in his career. It was the beginning of the appreciation of his scholarship and researches in Mathematics. Ramanujan, disappointed at the lack of recognition, had bemoaned to a friend that he was probably destined to die in poverty like Galileo. This was not to be.

The life of Ramanujan, in the words of C.P. Snow, "is an admirable story, and one which showers credit on nearly everyone." Sir Francis Spring, the chairman of the Port Trust, encouraged Ramanujan in his mathematical pursuits. Sir Francis Spring drew the attention of Dr. Gilbert T. Walker, F.R.S. to Ramanujan's Notebooks.

Dr. Walker, a good mathematician and a fellow of the Trinity College, Cambridge immediately recognized the quality of Ramanujan's work. He wrote to Mr. Francis Dewsbur, the Registrar of Madras University, commending the work of Ramanujan. On the recommendation of Dr. Walker, Ramanujan was granted a special research scholarship of Rs. 75/-per month for two years with the express consent of the Governor of Madras at the University of Madras. As the first research scholar of Madras University he began his research career as a professional mathematician from May 1913.

Dr. Walker also wanted the University to correspond with Prof. G.H. Hardy of Cambridge.

By this time Ramanujan had started publishing his work. His first article on Bernoulli numbers was published in the *Journal of Indian Mathematical Society* in 1911 followed by two more articles in 1912. These had a good impact. Prof. C.L.T. Griffith of the Engineering College, Madras was impressed by these articles. He told Sir Francis Spring that Ramanujan was an extraordinary mathematician and that he should send some of his works to leading mathematicians in London.

By now Ramanujan had access to foreign journals from the library of the Indian Mathematical Society at Madras. In one of these journals Prof. Hardy had raised some queries that came to the attention of Ramanujan. Ramanujan had already made some contributions in the area related to the queries raised by Prof. Hardy. It was therefore easy for him to answer these queries. He wrote his answers in the form of letters to Prof. Hardy.

In 1913, Ramanujan wrote to Hardy as follows (S. Ramanujan, Collected Papers, 2nd Ed, Chelsea, New York, 1962, p. xxiii):

Dear Sir,

I beg to introduce myself to you as a clerk in the Accounts Department of the Port Trust office at Madras on a salary of only $20 per annum. I am now about 23 years of age. I have had no university education but I have undergone the ordinary school course. After leaving school I have been employing the spare time at my disposal to work at Mathematics. I have not trodden through the conventional regular course which is followed in a university course, but I am striking out a new path for myself. I have made a special investigation of divergent series in general and the results I get are termed by the local mathematicians as startling.....

I would request you to go through the enclosed papers. Being poor, if you are convinced that there is anything of value I would like to have my theorems published. I have not given the actual investigations nor the expressions that I get but I have indicated the lines on which I proceed. Being inexperienced, I would very highly value any advice you give me. Requesting to be excused for the troubles I give you.

I remain, Dear Sir, Yours truly,

S. Ramanujan

With his letter Ramanujan included about 120 theorems/ formulas.

One morning in January 1913, Prof. Hardy found among his letters on the breakfast table, a large untidy envelope decorated with Indian stamps. When he opened it he found that the letter was a little out of the ordinary. It consisted of some theorems very strangely looking without any proofs. Hardy thought for a moment that the writer of the letter might be a fraud. He duly went about the day according to his daily routine. But there was something nagging him at the back of his mind.

Anyone who could fake such theorems, right or wrong, must be a fraud of genius. He went that evening after dinner to argue it with his friend Prof. J.E. Littlewood. They worked together and it did not take them long to come to the conclusion that the writer of the letter was a man of genius. Hardy says, "A single look at them is enough to show that they could only be written down by a mathematician of the highest class. They must be true, if they were not true, no one would have had the imagination to invent them. ... The writer must be completely honest, because great mathematicians are commoner than thieves or humbugs of such incredible skill."

Hardy immediately decided that Ramanujan must be brought to England. He entrusted Prof. Neville with the responsibility of bringing Ramanujan to London. With the help of Prof. Neville, Ramanujan finally sailed to England from Madras on 17 March 1914. On 14 April 1914, he reached London through the channel. Ramanujan spent four very fruitful years at Cambridge, fruitful certainly to him, but more so to the world of mathematics. Hardy records that the time he spent with Ramanujan from 1914 to 1918 was one of the "most decisive events" of his life – Hardy's life.

Ramanujan was awarded the B.A. degree by research in 1916. Ramanujan published 27 papers, seven of them jointly with Hardy. In 1918 he was elected Fellow of the Royal Society and in the same year was also elected Fellow of Trinity College, both honours coming as the first to any Indian. The University of Madras rose to the occasion and made a permanent provision for Ramanujan by granting him an unconditional allowance of $ 250 a year for five years from April 1919, the date of expiry of the overseas scholarship that he was then drawing. At the same time a post of Professor was created by Madras University for Ramanujan, but alas, fate decided otherwise.

Sharp Memory

According to Littlewood, Ramanujan treated numbers (every positive integer) as his personal friends. There is an interesting anecdote in this connection. Around the middle of 1917, Ramanujan's health declined and he was admitted to a nursing home in Cambridge. Once Prof. Hardy visited him in the hospital. Finding Ramanujan depressed, he thought of cheering him up and remarked that the number of the taxi by which he came was 1729 and that it seemed to him to be a dull number, and that he was afraid it was an unfortunate omen. Ramanujan replied immediately: "No, it is a very interesting number as it is the smallest number that can be expressed as the sum of two cubes in two different ways as $1^3+12^3 = 1729 = 9^3+10^3$".

Then, Hardy asked him, whether he could tell the solution of the corresponding problem for four powers and he replied, after a moment's thought, that he knew no obvious example but felt that the first such number must be very large. In fact this observation of Ramanujan was true, since the simplest known solution of $x^4+y^4 = z^4+t^4$ is Euler's $(59)^4 + (158)^4 = (133)^4 + (134)^4 = 635318657$.

The anecdote reveals Ramanujan's remarkable feeling for numbers and his sharp memory which made him recall one entry out of several thousands he had made in his notebooks and the fact that he had not recorded in his notebook the observation he made about 1729 which came only when Prof. Hardy made an innocuous statement.

Hardy refers to a formula that Ramanujan was fond of: "There is one particularly interesting formula, viz.

$$x^{\&-1}\phi(O) - x\,\phi(1)+x2\phi(2) - \text{------}\ dx = \frac{\overline{\wedge}\ O(-S)}{\mathrm{Sin}\overline{\wedge}s}$$

of which he was especially fond and made continual use. This is really an 'interpolation formula' that enables us to say, for example, that under certain conditions, a function that vanishes for all integral values of its arguments must vanish identically. I have never seen this formula stated explicitly by anyone else, though it is closely connected with the work of Mellin and others."

The Rogers–Ramanujan Identities

In additive number theory, mathematicians study ways of writing integers as sums. The sums are called partitions. A partition of an integer N is a finite sequence a,b,c,d,e,.....r of positive integers, called 'parts' of the partition such that

a+b+c+d+...+r= N. For example, the seven partitions of 5 are

5 = 1+1+1+1+1
= 2+1+1+1
= 2+2+1
= 3+1+1
= 3+2
= 4+1
=5

Of these partitions, three have distinct parts: 5,4+1, 3+2, and three have only odd parts 5,3+1+1, 1+1+1+1+1. This phenomenon is considered in a two hundred year old theorem of Euler. Another example, 4,3,3,2 is a partition of 12. We write the partition as 4332 without even the commas separating the integers. 522111 is another partition of 12. We note that we always write a partition in such a way that as we read it, the parts do not increase. How many partitions are there of a given integer n? The answer is p(n) in standard terminology.

P(1) = 1
P(2) = 2, for 2 and 11 are the partitions of 2.
P(3) =3, for 3,21 and 111 are the partitions of 3.
P(4) = 5, for 4, 31,22,211 and 1111 are the partitions of 4.

And so on, P(200)= 397299029388. Thus p(n) becomes very large very rapidly.

Very little is known about the arithmetical properties of p(n). Even questions like whether p(n) is odd or even, for a given n, is difficult to answer. Ramanujan was the earliest mathematician to enquire into such properties. Ramanujan observed properties like the following. Whatever integer n might be, p(5n+4) is divisible by 5, p(7n+5) is divisible by 7 and similar ones. In connection with these properties, Ramanujan proved a number of identities, one of which is

$$p(4)+p(9)x+p(14)x^2+ -- = \frac{5\{(1-x^5)(1-x^{10})(1-x^{15}) ---\}^5}{\{(1-x)(1-x^2)(1-x^3) ---\}^6}$$

This result has been considered to be representative of the best of Ramanujan's work by Hardy. Hardy says: "If I had to select one formula for all Ramanujan's work, I would agree with Major MacMahon in selecting the above."

In 1918, Hardy and Ramanujan published a joint paper in the *Proceedings of the London Mathematical Society* on an exact formula for p(n), Euler's Theorem. For any positive integer n, the number of partitions of n with distinct parts equals the number of partitions of n with odd parts.

Basic properties of arithmetic can be used to prove Euler's theorem. The theorem is proved by showing explicitly how to transform all the partitions with odd parts into the partitions with distinct parts. The procedure is as follows:

1. Collect like terms

Thus, if we start with partition of 44
7+7+7+7+3+3+3+1+1+1+1+1+1+1
The first rule produces 4x7 +3x3+7x1
The numbers appearing first in each multiplication are called coefficients.

2. Write the coefficients or sums of distinct powers of 2 (The powers of 2 are the numbers 1,2,4,8,16,32,64,128,256,512,1024,.....). Thus 4x7+3x3+7x1 becomes (4)x7+(2+1)x3+(4+2+1)x1

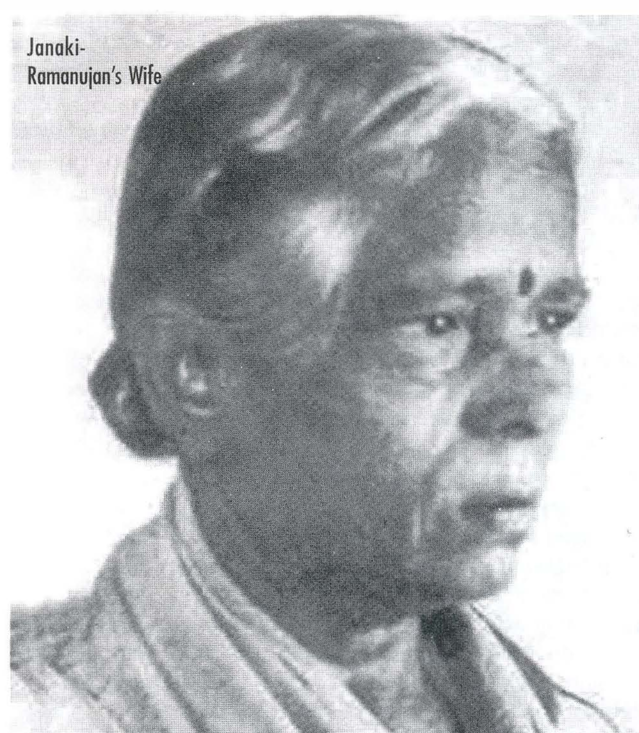
3. Carry out the indicated multiplications.
Thus (4)x7+(2+1)x3+(4+2+1)x1= 28+6+3+4+2+1,
Which is a partition of 44 with distinct parts.

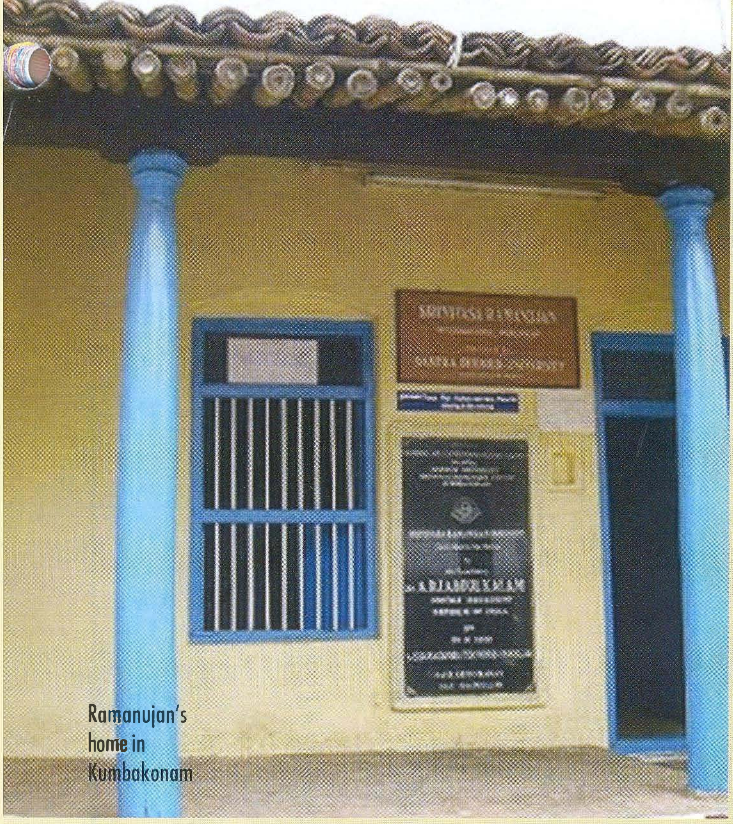
Let us now apply our three rules to the partition of 5 with odd parts:

5= 1x5 = (1) x 5 =5
3+1+1 = 1x3+2x1 = (1)x3+(2)x1 = 3+2
1+1+1+1+1 = 5x1=(4+1)x1 = 4+1

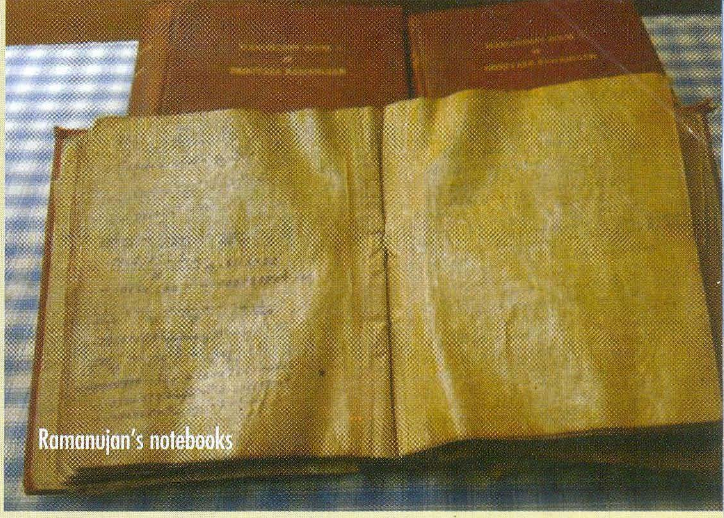
Lo and behold, our rules have, as was suggested, yielded all the partitions of 5 with distinct parts. One may use the fundamental properties of arithmetic to establish that indeed our rules always provide a proof of Euler's theorem.

For almost 150 years no other theorem of this type was found. Ramanujan and L.J. Rogers independently found a theorem that is much deeper than Euler's though it looks almost the same. Odd numbers may be characterized as integers whose last digit is 1,3,5,7 or 9. Let us call integers strange numbers if their last digit is 1,4,6,or 9.


Janaki- Ramanujan's Wife



Ramanujan's home in Kumbakonam



Ramanujan's notebooks

Srinivasan Ramanujan lived only for thirty-three years. For him also, life was not a bed of roses – but he remained engrossed in his mathematical passion notching up several milestones in his short life span.

The Last Days

Ramanujan's achievements were all about elegance, depth and surprise beautifully intertwined.

Unfortunately, Ramanujan contracted a fatal illness in England in 1918. He convalesced there for more than a year and returned to India in 1919. His condition then worsened, and he died on 26 April 1920.

One might expect that a dying man would stop working and await his fate. However, Ramanujan spent his last year producing some of his most profound mathematics. A moving description of this time is given by Ramanujan's wife:

He returned from England only to die, as the saying goes. He lived for less than a year. Throughout this period, I lived with him without break. He was only skin and bones. He often complained of severe pain. In spite of it he was always busy doing his mathematics. That evidently helped him to forget the pain. I used to gather the sheets of paper that he filled up. I would also give the slate whenever he asked for it. He was uniformly kind to me. In his conversation he was full of wit and humor.

Even while mortally ill, he used to crack jokes. One day he confided in me that he might not live beyond thirty-five and asked me to meet the event with courage and fortitude.

He was well looked after by his friends. He often used to repeat his gratitude to all those who had helped him in his life."

Ramanujan was born 124 years ago. His life was tragically short. However, his mathematical discoveries are still alive and flourishing. "Ramanujan is important not just as a mathematician but because of what he tells us that the human mind can do," said Prof. Askey. "Some one with his ability is so rare and so precious that we can't afford to lose them. A genius can arise anywhere in the world. It is our good fortune that he was one of us. It is unfortunate that too little of Ramanjuan's life and work, esoteric though the latter is, seem to be known to most of us."

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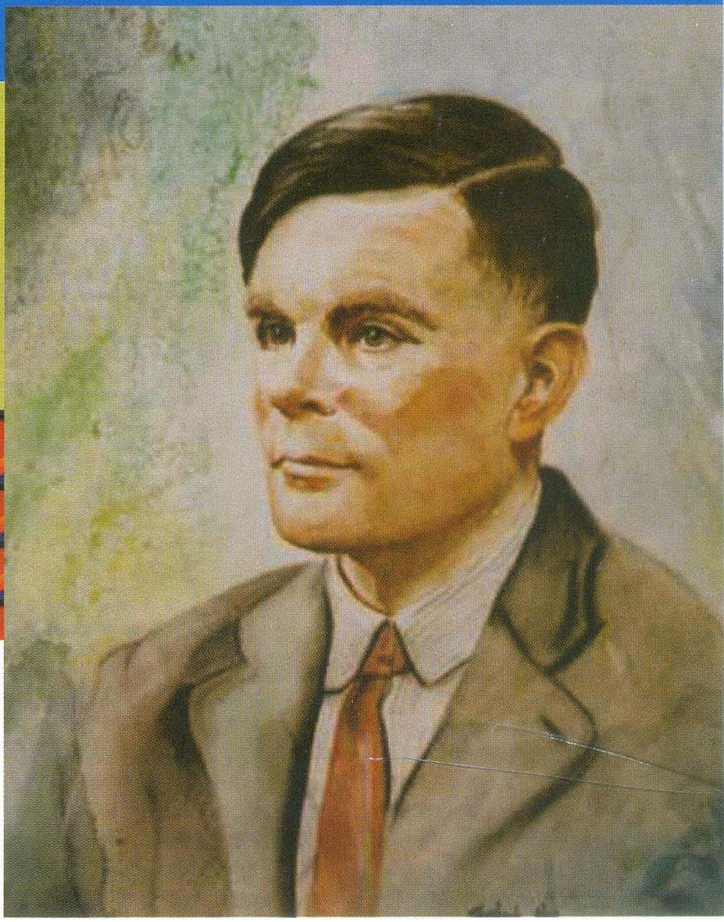
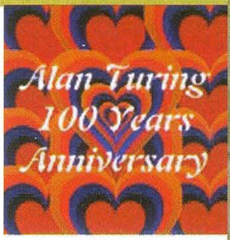
Feature Article

Alan Mathison Turing
A Man of Machines

The world celebrates the hundredth anniversary of Alan Turing who laid the foundation for the 'intelligent machine'

Manas Pratim Das





Dip the apples in the brew, Let the sleeping death seep through…

Alan Mathison Turing committed suicide on 8 June 1954. His body was discovered with an apple lying half-eaten beside his bed.

It is extremely unlikely that Adolf Hitler knew about a British mathematician called Alan Mathison Turing but had Hitler somehow known the fellow he could have identified one more factor that led to his downfall. War historians might scoff at giving too much importance to an individual in deciding the outcome of the Second World War.

But they would be uncomfortable in ignoring the role Turing played in cracking the codes created by the mighty German Enigma machine. Surely, breaking the Enigma code is not the only contribution that Turing made in his lifetime but it was certainly the most important from the historical viewpoint.

Alan Turing returned from America to his homeland England in the fall of 1938 after having turned down an offer to work as John von Neumann's assistant at Princeton. In June of that year he had earned his PhD with a groundbreaking dissertation titled *Systems of Logic Based on Ordinals*.

Back home, he was recruited to join a course on cryptography and encipherment sponsored by the Government Code and Cipher School in London. The school's director Alastair Denniston had heard about Turing's exceptional mathematical ability and was keen on having him among his students. Turing understood the need and was willing to help.

This course and the associated stream of events finally led him to Bletchley Park. Whatever it meant to lay citizens, Bletchley Park, after the autumn of 1939, had become the address of Britain's core group of codebreakers. The German *blitzkrieg* that was conquering countries at a very fast rate had to be thwarted. The Allies, of which Britain was a part, knew that their best bet lay in cracking the secret German code that was making German military progress possible.

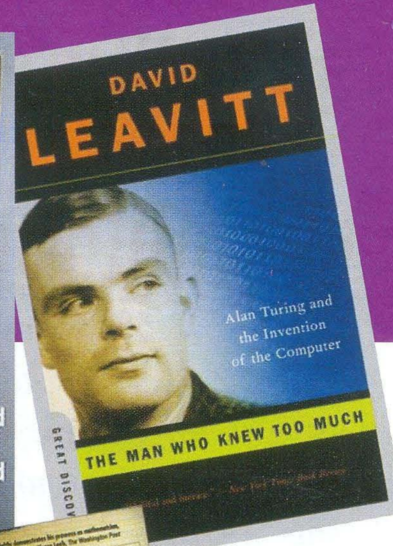
Communicating through secret ciphers or codes had been in vogue since time immemorial. Every major user had tried to make his code more complex so that it became unbreakable. But in every age a solution had somehow sprung up. And therefore, no code had been absolutely secure. The Enigma code did succumb to this age-old rule but before that it had set superior standards in encipherment.

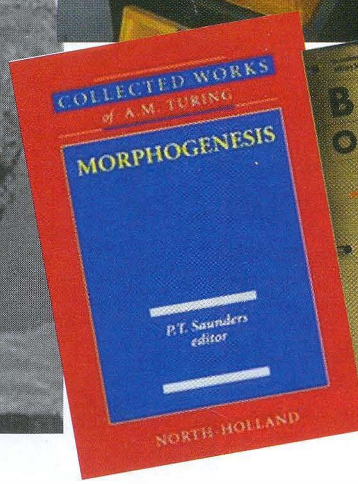
The Machine

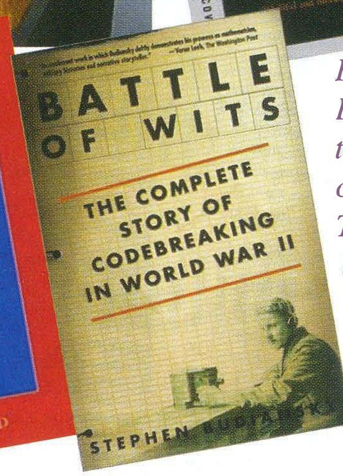
At the end of the First World War the decimation of Germany began through the Treaty of Versailles. It was an unjust and highly biased treaty where the victorious Allies put all the blame on Germany and made it pay heavily for the damages. But deep inside the German psyche there remained an anguish and zeal to avenge this injustice. The Enigma machine can be thought of as being a product of this mentality.

Electrical Engineer Arthur Scherbius designed this machine to replace the inefficient systems of cryptography used in the First World War. It will be wrong to term his effort as 'all patriotism' and 'no profit seeking' because he had made all

A slate statue of Alan Turing with the famous Enigma machine







Breaking the Enigma code is not the only contribution that Turing made in his lifetime but it was certainly the most important from the historical viewpoint.

necessary arrangements to rake in profit through the sale of his innovation. He founded a company with his friend Richard Ritter and took out a patent for his machine.

It was a formidable cipher machine that combined electrical and mechanical parts. However, the person in charge of encrypting a plain text message for onward transmission was not required to know the structural intricacies of the machine. He could just type the text on the keyboard of the machine and receive a jumbled collection of letters in return. That was the coded message. The receiver, in turn, had to type the apparently meaningless code on the keyboard and voila, he saw the meaningful text message in front of his eyes.

Thus, from the user's point of view it was very friendly and therefore commercially successful. Once the machine was made robust and its usefulness established the German military placed heavy orders for its purchase. In 1925, Scherbius began mass production of his machine for supply to the military forces.

As Simon Singh puts it in his bestseller *The Code Book*, "Over the next two decades, the German military would buy over thirty thousand Enigma machines. Scherbius' invention provided the most secure system of cryptography in the world, and at the outbreak of the Second World War the German military's communications were protected by an unparalleled level of encryption".

Attempting A Break

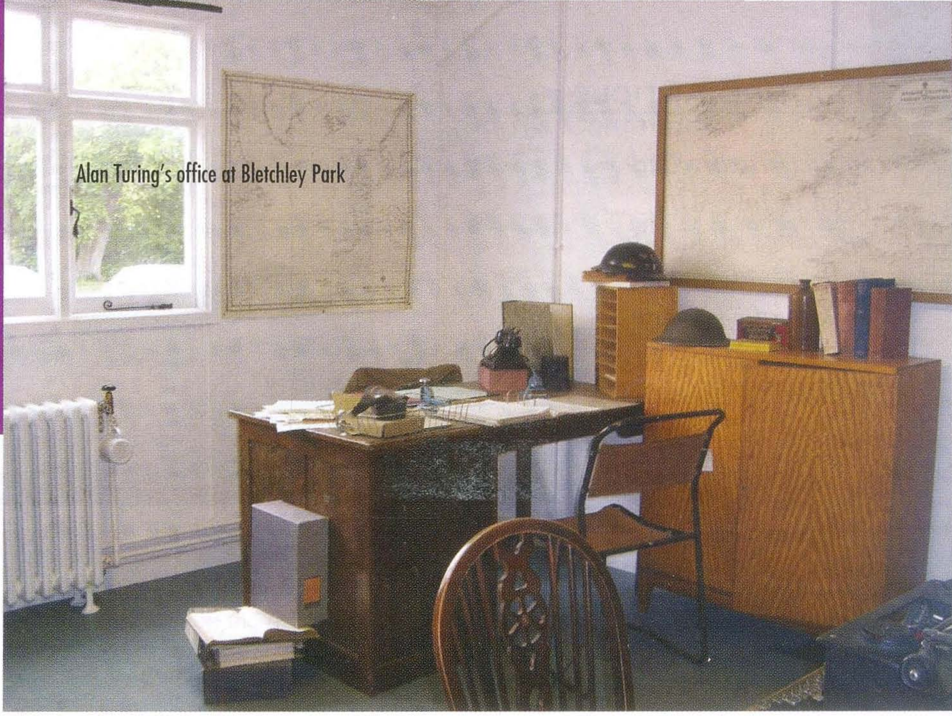
Germany's neighbours and its adversaries could not sit idle and watch Germany's secret communications go from strength to strength. They had to do something in order to ensure their safety in the years preceding the Second World War. But apart from discovering a traitor in the form of Hans-Thilo Schimdt who supplied the design of the Enigma machine, the French could achieve nothing in this regard.

Poland, however, was desperate to gather information regarding Germany's communications. It had gained independence in the aftermath of the First World War but was afraid that Germany might any day lay claim to its territory. They set up a secret bureau mainly with the aim of cracking Enigma codes. The genius who led the mission was called Marian Rejewski.

Over the years Rejewski built up an elaborate system to decipher Enigma codes. His major achievement lay in discovering the method for finding the key for encipherment. The Germans changed the key everyday or even sometimes once in a few hours and it was the heart of encipherment. Rejewski kept pace with the German military as they made changes to the machine in order to make the encoding a more complex process.

By 1938, the Poles were at the peak of their code breaking success. But then a host of changes at the German end rendered their setup insufficient for the process of code breaking. It was at this point that the Poles invited the British and French cryptanalysis and sought their help. They handed over their technologies and made a fervent plea to carry on with the process. Everyone could sense that a big war was approaching and the British marshaled its strength to take up the Enigma challenge.

Every major user had tried to make his code more complex so that it became unbreakable. But in every age a solution had somehow sprung up. And therefore, no code had been absolutely secure.



Alan Turing's office at Bletchley Park

Cracking it at Bletchley

On 4 September 1939, Alan Turing reported to Bletchley Park. It was actually a massive building in Buckinghamshire, about fifty miles northwest of London. Admiral Quex Sinclair had bought the house to serve as the base for the functioning of the General Code and Cipher School. It was undoubtedly a center of military activity but the group that arrived there, Turing included, had very little respect for formal behavioural manners.

There were mathematicians other than Turing. Two of them were fellow Cambridge mathematicians namely Gordon Welchman and John Jeffreys. There was another called Peter Twinn. Apart from mathematicians the team had experts from other areas of knowledge also. Hugh Alexander, the British chess champion was there alongwith the writer Malcom Muggeridge. The military establishment had also ensured the services of winners in a competition to solve the *Daily Telegraph* crossword puzzle as fast as possible.

The mathematicians staying at a low building called the Cottage first concentrated on the techniques of code breaking invented by the Poles. Rejewski and his team had built machines to aid their effort. Those were called *bombes*. Several explanations existed as to why it was so named with no particular one claiming to be the correct one. The British establishment retained the name but decided that more developed machines had to be built to crack the Enigma codes.

Turing was the one who designed a new generation of *bombes*. Back in Princeton he had built an electronic multiplier that could encipher messages by multiplying large binary numbers together. So he was the really experienced one in this regard and the responsibility fell on his shoulders.

In fact, Turing had been in love with machines all his life. In 1937, about a couple of years after he was elected a fellow at King's College in Cambridge, Turing saw his revolutionary paper come out in the *Proceedings of the London Mathematical Society*. It was titled "On Computable Numbers, with an Application to the *Entscheidungsproblem*". In it Turing proposed to build a machine that would determine the solvability of the classical *Entscheidungsproblem* or the decision problem. To propose such a step needed sheer courage and radical thinking.

As David Leavitt explains in his book *The Man Who Knew Too Much*, "To speak of a hypothetical computing 'machine', especially in a mathematics paper in the 1930s, was to break the rules of a fairly rigid orthodoxy. No such machines existed at the time, only calculating devices too crude to undertake any complex mathematics, and certainly not programmable." Leavitt is only correct when he writes in such a manner.

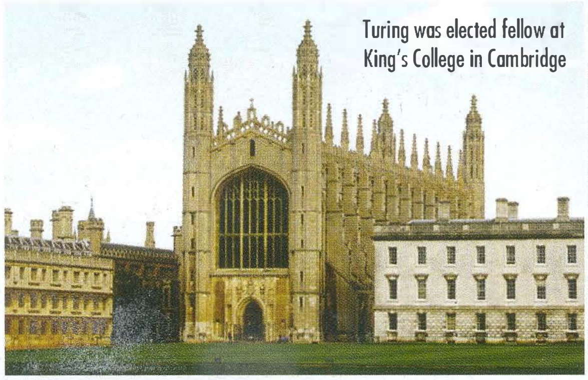
G.H. Hardy, the famous number theorist, had earlier summarily dismissed the proposition of mathematicians making their discoveries by turning the handle of a miraculous machine. Hardy simply represented the views of his peers. But Turing was a different breed altogether and thus he could say at one place in his paper: "According to my definition, a number is computable if its decimal can be written down by a machine."

Turing's *bombes* kept the British armed forces informed about all the German measures. As Turing and his colleagues built on their successes the British could anticipate every attack from the German end. When Turing eventually cracked the naval Enigma code of the Germans it spelt doom for Hitler's war efforts. Immediately there was a sharp decrease in the number of Allied ships sunk by German U boats.

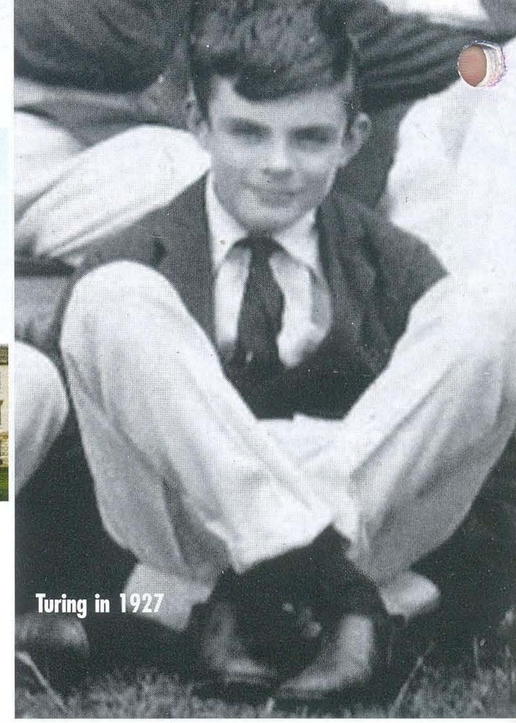
One might question the correctness of awarding all the credit of these successes to Turing alone. However, historian Stephen Budiansky puts all such doubts to rest by stating that "the fundamental mathematical insight behind the British *bombe* was wholly Turing's". In his book *Battle of Wits: The Complete Story of Codebreaking in World War II* he gives a neat and vivid description of Turing's

Commemorative stamps on Turing

In fact, Turing had been in love with machines all his life. In 1937, about a couple of years, he was elected a fellow at King's College in Cambridge.



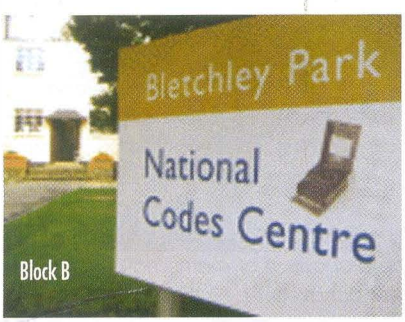
Turing was elected fellow at King's College in Cambridge



Turing in 1927

method that later came to be known as Banburismus or more generally as Turingismus.

Andrew Hodges, the biographer of Alan Turing, underlines his prominence at Bletchley Park with these words: "By 1942, Alan Turing was the *genius loci* at Bletchley Park, famous as 'Prof'. There could be no



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debate over his contribution to the victory of the Allied Forces in the greatest battle fought on this planet."

However, Turing and all other inmates at the Bletchley Park received no official recognition after the end of the War because cryptanalysis has always been a clandestine activity and thus Bletchley's achievement remained a closely guarded secret even after 1945. It was not until 1974 when Captain F.W. Winterbotham obtained permission from the intelligence services to write a book on the codebreakers that the deserved recognition finally came through.

The Real Turing

Turing started to remove himself from the intense activities at Bletchley Park by the middle of 1942. There was no dearth of work, of course. Max Newman, his mentor at Cambridge, had arrived to take care of the Fish traffic, which was a stream of codes enciphered on a teleprinter. He contributed, even if in a small way, to the building of the Colossus that would effectively decipher the Fish traffic flowing from the German end. But his heart was yearning for more.

Alan Turing wanted to build a machine that would be more general in nature, not like the ones he had dedicated to cryptanalysis. His travel to the United States in November 1942 as part of the decipherment programme helped him a lot. The Bell Labs nourished him with fresh ideas and Claude Shannon of MIT shared his own romanticism of building a machine that would understand the recital of poetry.

In June 1945, Turing joined the National Physics Laboratory at Teddington, which is a suburb of North London. As one of the premier institutes of Britain it was engaged in the task of catching up with America's progress in computing. In that very year two large computing machines, ENIAC and EDVAC from America had set the trail blazing. Now Turing had a real challenge in hand.

He presented his plans to the authorities of the institute of building a machine that would be called ACE, short for Automatic Computing Engine. He insisted that his machine would be a digital one and it would 'learn' by experience. Unfortunately it ran into competition with another machine proposed to be developed by his former classmate Maurice V. Wilkes. As history would have it, the soft-spoken Turing was finally nudged out of the programme though the Pilot ACE was finally built after a fashion.

In 1948, Turing moved to Manchester University at the invitation of Max Newman. There, as Leavitt says, "The machine on which Turing went on to work was a preliminary model intended for small-scale experiments, and thus christened (in keeping with Turing's educational program) the Baby."

Though it became operational in June 1948 it was an extremely difficult machine to handle. It ran into more difficulty when the media riding on a lecture by Sir Geoffrey Jefferson of the Department for Neurosurgery at the Manchester University started attacking the Manchester computer. In fact Jefferson had drawn his ideas from the American Norbert Wiener who is called the Father of Cybernetics. His book *Cybernetics* released in 1948 had stirred the whole world and introduced new thoughts about intelligence of machines.

Wiener was fond of Turing and paid a visit to him in the spring of 1947. Having learnt this Jefferson concluded that Newman and his colleagues at Manchester were actually up to building machines that would compete with human beings. He painted this effort in a light that suited the gibberish of a popular media and the *Times* was very quick to take advantage. It aroused public sentiment against Newman's machine. But Jefferson failed to realize that Newman's team was far from building a robust computing machine, let alone enriched with human intelligence.

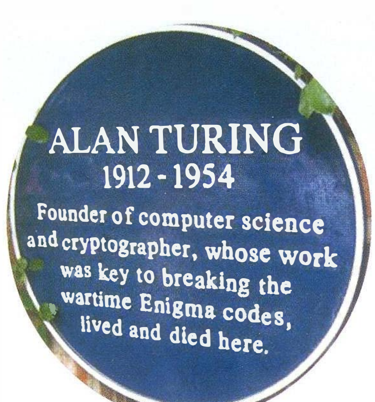
However, not all was in vain as far as the Baby or Manchester Mark 1, as it was later called, was concerned. Thirty-four patents resulted from the machine's development, and many of the ideas behind its design were incorporated in subsequent commercial products such as the IBM 701 and 702 as well as the Ferranti Mark 1. The Manchester Mark 1 continued to do useful mathematical work between 1949 and 1950, including an investigation of the Riemann hypothesis and calculations in optics.

But Turing was inextricably engrossed in his idea of building intelligent machines. In October 1950, his paper titled 'Computing Machinery and Intelligence' appeared in *Mind*. While Wikipedia like many others calls it a 'seminal paper' Leavitt had termed it as Turing's 'most perverse paper'.

In it Turing counters every objection to an intelligent machine in his own inimitable style. He even takes on the theological challenge saying that he is 'unable to accept' the theory that "Thinking is a function of man's immortal soul. God has given an immortal soul to every man and woman, but not to any other animal or to machines. Hence no animal or machine can think."

He puts forth his conviction in the concluding paragraph in these words, "We may hope that machines will eventually compete with men in all purely intellectual fields." In this very paper he introduced the *Turing Test* that determines a machine's ability to exhibit intelligent behaviour. This single paper can explain why Wiener was so fond of Turing and why Alan Turing shares the honour of being the father of Artificial Intelligence with Norbert Wiener.

That he would go ahead to work on mathematical biology especially morphogenesis for the last two years of his



Turing took an intense liking to the film 'Snow White...' and would keep reciting lines from it.

life is no wonder when we consider his zealous attempt at integrating man and the machine.

Snow White and the Seven Dwarfs

The 1937 animated version of the *Snow White and the Seven Dwarfs* produced by Walt Disney was released in America in 1937 but its British premiere took place in the following year. Turing took an intense liking to the film and would keep reciting lines from it. While it might be overtly melodramatic to mention his chanting of two particular lines from the film as he walked through the corridor of King's at Cambridge, it is difficult to resist the temptation. The lines are:

Dip the apples in the brew,
Let the sleeping death seep through...

Alan Mathison Turing committed suicide on 8 June 1954. His body was discovered with an apple lying half-eaten beside his bed, and although the apple was not tested for cyanide, it is speculated that this was the means by which a fatal dose was delivered. Turing had taken the two ominous lines to his end.

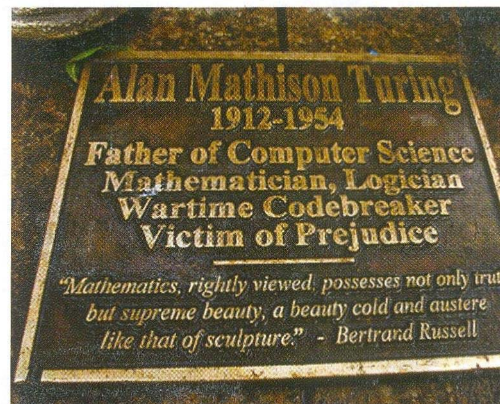
It was not a sudden suicide. Without going into the details that have been written many times since his death it is enough to say that he was charged with homosexuality under the Criminal Law Amendment Act 1885. Homosexual acts were illegal in the United Kingdom at that time and so he was charged with gross indecency. Turing was frank about his sexual behaviour but he had to accept the consequences.

He was given a choice between imprisonment or probation conditional on his agreement to undergo hormonal treatment designed to reduce libido. He accepted chemical castration via oestrogen hormone injections. As Hodges writes, "Once arrested, Turing was turned into a class traitor and cold-war risk in the moral panics and national security crisis of 1952. Amidst this, for him the issues of truth and trust were paramount. *Turing believes machines think, Turing lies with men, Therefore machines do not think,* he wrote, camp humour combined with mathematical camp, but with truth at the centre."

On His Centenary...

Though Alan Turing was born in Maida Vale, London on 23 June 1912 he was actually conceived in Chhatrapur of Orissa in India. His parents moved to England, as they wanted their child to be educated in their homeland. We can vaguely be proud of this Indian connection during his centenary celebrations.

As ordinary world citizens we might also ponder over what he could have achieved if left to grow normally into a mathematician like G.H. Hardy. He was different from Hardy in the sense that he wanted to make mathematics 'useful' which Hardy abhorred. To him reality mattered as he had curtly told the Austrian



Alan Turing was actually conceived in Chhatrapur of Orissa in India. His parents moved to England, as they wanted their child to be educated in their homeland.

philosopher Ludwig Wittgenstein who was totally against creating an interface between pure logic and real circumstances.

He was extraordinary in tackling the decision problem or *Entscheidungsproblem* with a Turing machine. A point may come when all his extraordinary attributes along with his truthfulness and romanticism might gel into a surreal mix in our minds. That is the perfect time to remember his epitaph where is written:

Hyperboloids of wondrous Light
Rolling for aye through Space and Time
Harbour those Waves
which somehow Might
Play out God's holy Pantomime

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The Cold Story

VARNIT P. SINGH

"Aachoo!"

"You look ill, Sarah. I told you not to eat ice-cream again."

"But, Mom its just common cold. I'm not seriously ill. There is nothing to worry Mom."

"Sarah, why do you take everything so casually? Sometimes even common cold could be..."

"Mom! Look out!!"

"What! Oh my..."

BANG!

Slowly months passed. Anne and Tom would spend hours and hours talking with Sarah. Sometimes, when Anne would go to meet Sarah, she could see Tom already present there talking and laughing with her....

300 years later

Anne could sense that something was not right with her younger brother today. The sandwiches that she had prepared for him lay cold on his plate. He seemed to be lost in a world of his own. She decided to bring him back to her own world again.

"What's the matter, Tom? Not hungry today?"

"Huh? Oh! No! No! Anne! I'm fine," said Tom taking the sandwich. "I'm just a bit nervous today, Sis."

"I can see that Tom. You know, you can always tell me. May be I could help?"

"Haha! Anne you're a biologist. You deal with living things, where as I deal with the dead. How could you help me in this?" asked Tom.

"So, this is related to your work, Tom. Hmm! What is it?"

"Well, Anne! Do you remember me telling you about patient Number One?"

"Oh! Yes! I do. I remember that it was named so because it was the first patient ever brought into your lab."

"Today is its day Anne! Today we're going to bring it back to life again. And, I have been chosen for this task. That's why your brother is so nervous today."

"Can I accompany you to your lab today, Tom?"

"You mean like our Mom used to accompany us when we had the toughest test in the school," asked Tom. "Oh! Anne! I miss Mom so much sometimes."

"I miss Mom and Dad too. Well then, finish your breakfast fast, and then let's go."

******

To Anne, the inside of a cryonics lab looked like a college dormitory. It was like hundreds of students sleeping in their respective dorms. Maybe for this reason, thought Anne, each cryopreservation room of the patient was known as 'dorm' here.

Placing a thick file on Anne's hands, Tom had just entered the dorm of patient 'number one'. Anne could see him and his other colleagues operating through the glass walls. Then, she started moving to the end of the corridor.

Anne always loved coming here. The lab was like a second home to her. Her brother, Dr. Thomas Albert, worked as a senior cryonics scientist here. Her Mom and Dad were here too. They were themselves once scientists here, but now had donated their bodies to the lab for experimentation.

Anne could see her Mom and Dad sleeping serenely through the glass. She pulled up a chair, and sat there looking at them. It was then she became conscious of the file she was holding until then – *Number one's file*. She started going through its pages.

Name: Sarah Davies

Age: 19 (at the time of admission)

Reading it further, Anne learnt that Sarah was brought here in a critical state with some head injuries that needed immediate attention. She was in a coma. But, the technology at that time wasn't so advanced to deal with those injuries. Instead, she was kept at low temperature to save her for some more time. And, this worked as a wonder! Her head injuries were arrested at that present state and there was no further damage to the cells.

Her father, who was a rich businessman, provided all of his money to fund this lab, so that she could remain in that state for many, many years. Later, thanks to technological advancements in the field of cryonics, her body could be cryopreserved for 300 years. Once the lab's first patient, Sarah had now acquired the status of a star in this lab.

Finally the *'resuscitate operation'* on Patient number one was over. Anne could tell from everyone's faces that it was a success. Tom went straight to Anne. He hugged her.

"Anne I did it!"

"I always knew you would be able to do it my brother," said Anne smiling to him.

"Well, I'm happy for one more reason actually. We wanted to have someone with patient number one to socialize. Actually, she is now waking up in an altogether different world. It would not be possible for her to adjust with it so easily. Her Mom and Dad are no more here, so it's us who have the responsibility to make her feel at home. And, I recommended your name. And, they all agreed."

"Wow! Thanks Tom! I'm dying to meet her. I'm sure we would be best friends very soon. You don't worry, I'll manage it. You know, I'm good at socializing with people," exclaimed Anne.

The next morning, Anne met Sarah. And as time passed, she was able to make Sarah understand what happened with her, how her mother died in that car accident, why she was here, what her Dad did for her, and how she had woken up after 300 years in an altogether different world. But, her body had only aged about three years, because in cryopreservation for every 100 years the body only ages 1 year.

She explained to her how the present world was much more advanced than her 20^{th} century world. Diseases were scarce now as most of the diseases had been eradicated from the earth altogether, and the average age of people was above 100 years. But, in other physical aspects they were still the same, though there were slight changes at the genetic level now.

*****

Slowly months passed. Anne and Tom would spend hours and hours talking with Sarah. Sometimes, when Anne would go to meet Sarah, she could see Tom already present there talking and laughing with her. She could sense love in the eyes of Tom for Sarah. There was always a charm on his face whenever he was with Sarah. Anne too liked Sarah a lot, but she still didn't know what Sarah had in her mind, so one day she asked Tom if he could bring Sarah to show his home. Tom was very glad to hear this.

So, one fine Sunday morning Sarah was sitting with Tom and Anne eating homemade pancakes and sandwiches.

"It looks like it has been ages since I ate such a delicious food," said Sarah.

"Well, Sarah, it actually has been ages. Weren't you sleeping for 300 long years... haha," teased Tom.

"Tom! Now, don't you start teasing her in front of me. Well, Sarah, tell me what do you want to eat today. You just name it, Tom will bring it for you," said Anne winking at Tom.

"Umm... can I have some ice-cream. I'm sure you guys still have ice creams! It would be impossible to imagine the world without them," said Sarah greedily.

Anne looked weaker now. Her eyes could barely open. She wanted to say something, but no words came from her mouth. Sarah could not bear to look at Anne anymore and she came back to her dorm and shut herself ....You guys brought me back to life when I was supposed to be dead some 300 years ago....

"Haha.. We have them Sarah. Well, you two just wait, let me bring it for you guys," offered Tom.

Soon, he was back with three big cups of ice creams. When Sarah swallowed the first bite, she felt in heaven again. By the end of the day when Tom dropped Sarah back to the lab, she had already consumed five cups of ice creams.

When Anne went to meet Sarah next morning, Sarah was suffering from cold. Anne had to come alone that day because Tom was away attending a conference on the "Future scope of Cryonics" in London.

"How are you today, Sarah?"

"Aachoo! I think, I have cold today. I should not have eaten so many ice-creams yesterday."

"Cold? Anyways Sarah, I came to take you home with me today. Tom is away for three days, so you can come with me, and we can have some fun time cooking, talking and watching movies."

****

The three days passed like a tick of the clock, and Tom was back home on the third day.

"Anne! Anne! Where are you? See I've got a gift for you from London." But, no one answered. So, he went straight to Anne's room.

"Anne! Oh My God! What happened to you? Why are you covered in blankets. Is something wrong with you?"

"Aachoo! I have cold, Tom."

"Cold? What is that? I never heard a disease of this name."

"I too don't know what it is. Sarah told me that I have cold, but she assured me that I would be fine in a few days."

But, Anne was anything but fine even after a few days. Her nose was always running and red. Wherever she went, she could be heard producing just one sound – Aachoo!

By the end of the week, the entire city could be heard producing this weird nasal sound. It was now the new fashion in the city. People considered it cool and enjoyed sneezing in public. Slowly, it spread to the entire British islands.

In the meanwhile, Sarah missed Anne. Tom had told her that Anne was still afflicted with this disease called 'cold', but her condition was stable due to some medicines he had given her.

*****

One day, Sarah went to see Anne. Anne had become very thin by now. She always had a headache, and was barely able to speak. Her nose was blocked, and eyes were red with tears. Sarah knew Anne now had severe cold, but she could not understand why Tom had not done anything. She asked him.

"You know Sarah, the problem is this disease doesn't belong to the present world we live in. It belonged to your world. We have long ago removed it from the earth. Now you have brought it back. So, scientists are again studying it and trying to develop a vaccine against it. You don't worry, everything will be fine soon."

******

Now, Sarah was also falling in love with Tom slowly and gradually. She would keep on looking in his eyes while he told her stories of his childhood. Then, one day, Tom came and sat on his knees in front of her.

"I hope this is how they used to propose a girl in your days. Will you marry me Sarah Davies?"

Sarah was delighted. But, the moment she opened her mouth to say – yes, the device Tom was carrying rang, and a voice echoed from it.

"This is an emergency Dr. Albert. Your sister is in critical condition."

Tom and Sarah immediately rushed up to the hospital in which Anne was admitted. Anne looked weaker now. Her eyes could barely open. She wanted to say something, but no words came from her mouth. Sarah could not bear to look at Anne anymore and she came back to her dorm and shut herself off to the outside world. She knew it was she who was responsible for Anne's condition. Her mother had once told her that even a common cold could be a dangerous thing. But, she never listened. And, now she was facing the consequences.

She switched on the digital screen she had in her room. It showed the widespread transmission of the 'common cold'. It had already reached the European countries now. And, a few reports showed that some Asian countries were also affected by it. There was a sense of panic in the world. In Britain, people had already started dying. Ten deaths had already been reported, and many hundreds were reported to be critical including Anne.

Sarah just cried and cried that night. She knew she had brought chaos in this world. She had infected this world with a virus she was carrying from her own world. She was now a monster, a monster that had already taken 10 lives, and was waiting to take more. She no longer wanted to live. Soon she fell asleep.

She woke up, when she heard Tom entering her dorm. He looked pale. She didn't have courage to ask him about Anne. But, he seemed to have understood her questioning looks.

"Don't worry. Anne is okay. Doctors are really trying hard."

But, she sensed there was something still worrying Tom. She waited for him to speak.

"Sarah! I need your help."

"I know Tom, what you are going to ask for. I thought about it too all night. I'm the cure of this disease. My body has antibodies to fight against it, while you guys don't have it. That is why it is producing havoc in your world. I'm ready Tom to give each and every drop of my blood to save everyone. You guys brought me back to life when I was supposed to be dead some 300 years ago. I owe this life to you. So, I'm ready to give this life again for you."

"Sarah, I love you. Sorry, I couldn't say that yesterday."

"I love you too, Tom. I'm very happy to meet a guy like you."

They embraced each other for one last time. Then, Tom's colleagues entered the dorm and started preparing Sarah to make her sleep for forever now.

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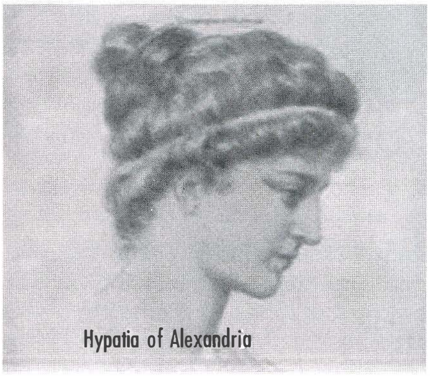
Fascinating World of Mathematicians

PRAKASH MANIKPURE

THE country is celebrating the National Mathematical Year 2012 to commemorate the 125th birth anniversary of the Mathematical Wizard of India – Srinivasa Ramanujan. Mathematics is said to be the mother of invention in science. Mathematics has tremendous influence on every kind of human endeavour. It is closely linked to nature as nature loves symmetry.

The earliest known mathematical writer was the Egyptian Ahmes in 1650 BC who handled fractions and solved mathematical problems. But Scribes in the great river civilization of Egypt developed ways of representing numbers and solving problems about one thousand years before that are recognizably precursors of today's mathematical activity. However, Greeks were the first to develop the notion during 500-200 BC.

A research tradition in geometry grew up, whose basic results were codified by Euclid (300 BC) and culminated in the work of Archimedes and Apollonius. The Greek Mathematical tradition lasted for several centuries, exemplified by Ptolemy to the arithmetical investigations of Diophantus, who raised the solving of number problems to a new height. The history of mathematics can be told through the often tragic life of several ancient mathematicians.



Hypatia of Alexandria

Hypatia: The story starts from the sacrifice of the first woman mathematician, Hypatia of Alexandria (c 350-370—415). Hypatia's reputation as a mathematician has survived through the accounts of the 5th century historian of Constantinople, Socrates Scholasticus, and excerpts from earlier writers. Hypatia wrote books on mathematics that included a commentary on Diophantus. She lectured on mathematics and astronomy in Alexandria. It was the time when the Roman Empire was converting to Christianity. As a neuplatonist, she was thought dangerous by the more fanatical Christians and was set afire by a mob. The world lost a promising budding woman mathematician due to the madness of the Roman people.

Archimedes

Archimedes (c 287-212 BC): Archimedes of Syracuse was a great Sicilian Greek Mathematician, Physicist and inventor of laws of flotation. He created mechanics by discovering screw, compound pulley, lever and centre of gravity. He used geometrical methods to measure curves and the areas and volume of solids. He also calculated the value of ð (pi) with a remarkable accuracy at 3.1408 and 3.1429.

Archimedes also helped King Hieron of Syracuse detect the impurity in the golden crown without breaking it. After discovering the defect in the crown, he ran naked through the streets shouting "Eureka...Eureka", meaning "I have discovered".

At the age of 75 years, when Archimedes was working on mathematical problems, the Romans attacked Syracuse. A soldier asked him to surrender, but Archimedes unaware of any fear simply asked him to go away. The enraged soldier killed him brutally, and the world lost yet another legendary mathematician.

Euclid (lived 300 BC): Greek Mathematician, also known as father of geometry, Euclid's 13-volume treatise entitled, *Elements of Geometry* created history as there is no book except the Bible that was published more in number than Euclid's *Elements*. Even today, geometry taught in every school in the world is based on Euclid's books on geometry.


Euclid

The first volume deals with the point, lines, circles, triangles, etc, along with some postulates. The second volume contains methods for making geometrical figures. The third and fourth volume deals with circles. These volumes have been translated in to all main languages of the world. Once Euclid said to his King Ptolemy, 'in geometry there is no short cut or straight path to learn even for the King'. Many mathematicians like Riemann and Einstein derived inspiration from Euclid for their work.

Pythagoras (580 BC-500 BC): Pythagoras was an exiled mathematical genius of ancient times, most famous for the "Pythagoras theorem" in Geometry. He was of the opinion that, "The essence of all things is a number." He spent many years in Egypt, working out the relation between arithmetic and music. He also propounded the concept of earth as a sphere moving with the stars in circles in a spherical universe.

The political situation during those times led to his persecution and Pythagoras was exiled to Metapontum. Many Pythagoreans were also killed in the revolution. In Pythagorean view, number was seen as a pure magical entity and the key to religion and philosophy. His worthy contribution in mathematics can not be overturned even today.

Later, the idea that the cosmos is intrinsically mathematical was found in the work of Plato. The Greek mathematical tradition lasted for several centuries and ranged from the astronomical and geographical work, exemplified by Ptolemy to the arithmetical investigations of Diophantus who raised the solving of number problems to a new height.

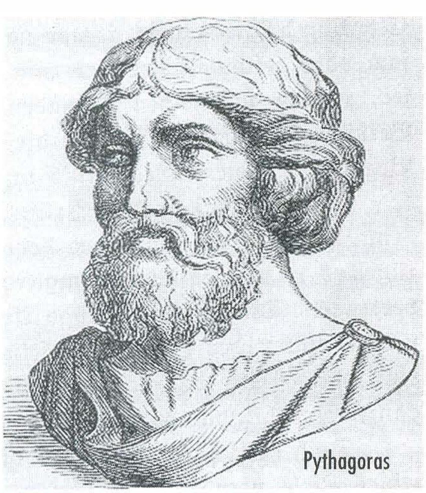
In c. 260 Chinese mathematician Lui Hui developed geometry and built the Chinese arithmetic-algebraic computational table to solve determinate and indeterminate problems.

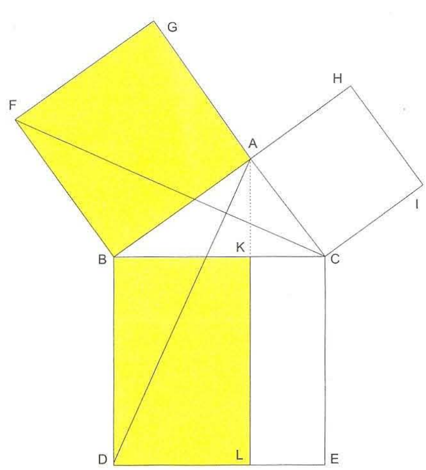
Rene Descartes (1596-1650): Descartes, who died due to pneumonia fever, was among the earliest mathematicians who created human knowledge in mathematics, science and philosophy. He devised the "Cartesian System" in co-ordinate geometry, which allows the points to be described numerically on a set of two mutually perpendicular axes. He published his major treatise on the method of geometry. Once while on way to give discourses on philosophy to Queen Christina in the chill of the early morning, the icy wind and freezing cold temperature gave him pneumonia, resulting in his early death. His worthy research in mathematics can not be forgotten.

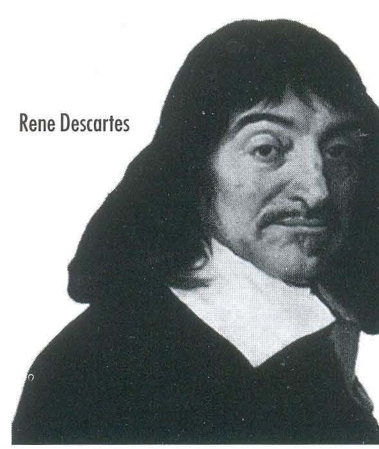
Blaise Pascal (1623-1662): French mathematician Pascal is famous for his discovery of the law of partial pressure in hydrostatics, calculating machine, theory of probability and integral calculus. His most notable invention was the Pascal theorem, according to which for any hexagon inscribed in a conic, the intersections of opposite pairs of sides are collinear. The SI unit of pressure – Pascal – is named after him. One Pascal is the pressure of one Newton force per square meter area.

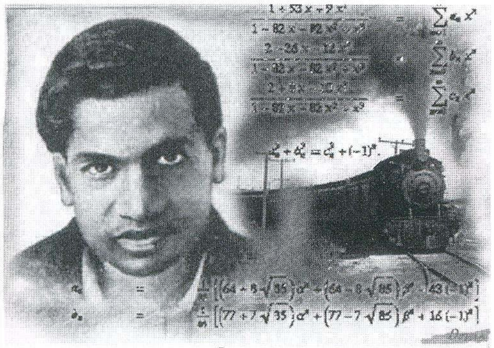
Ampere Andre Marie (1775-1836): French mathematician and physicist Ampere invented the mathematical formulation of electromagnetism in1827and derived the mathematical relation between magnetism and electric current. He suffered a series of tragedies. During the French Revolution his father was guillotined in Lyon. Ten years later, his adorable young wife died following the birth of his son. His second marriage was a disaster. Ampere's daughter who was married to one of Napoleon's Lieutenants in 1827 was a chronic alcoholic and the marriage soon proved troublesome. The SI unit of measuring the electric current is named after him as Ampere.

Jacob Jacobi (1804-1851): Jacobi, a German mathematician, invented the theory of elliptical functions, analysis, a number theory, and contributed much more in geometry and mechanics. He encouraged students to do original work. Once he told his students, "your father would never have married, and you would not be here now, if he had insisted on knowing all the beautiful girls in the world before marrying one." Jacobi developed hyper-elliptical functions and did significant


Pythagoras




Rene Descartes



Ramanujan

research on differential equations and determinants. However, his family pension was stopped on which his family and seven children lived, which led to his death at the early age of 47years.

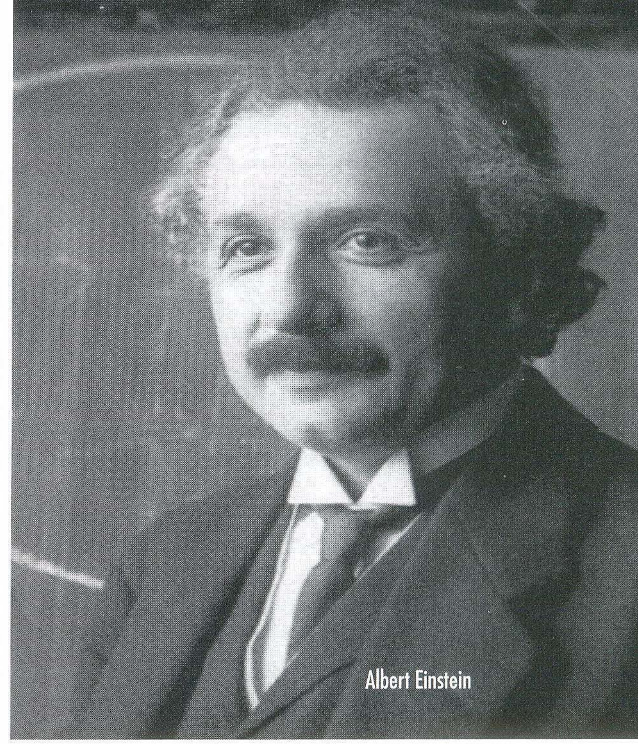
Golden Era of Mathematics

During the late 17th century, Europe saw not only a spectacular flourishing of mathematical creativity with mathematicians such as Napier, Fermat, Huygen, Newton and Leibnitz but also the growth of institutions for promoting scientific research and journals to communicate and broadcast the results. During the next century, mathematization of many diverse fields of human interest became fashionable in the wake of the enormous success of Newton's *Principia* (1687).

Mathematicians of the caliber of the Bernoulli family, Euler and Lagrange consolidated the methods of calculus, applied them to mechanics and developed new mathematical areas and approaches, notably, an increasing movement from geometry to algebra as the natural language of mathematics. The subject mathematics was promoted in education. About this time text-books were increasingly used, along with tests and examinations, to create mathematical syllabuses and new educational practices.

Mathematical activity in France (Monge, Laplace, Cauchy) and subsequently in Germany (Gauss, Dirichlet, Riemann) was strongly developed and professionalized, in both research and teaching. The growing importance of the numerical data in society led to the development of statistical thinking. The foundation of mathematics received growing attention in the 19th century, from the need to teach and explain the theorems of analysis.

Georg Cantor (1845-1918) explored the infinite and founded the theories of sets, while Dedkind, with his definition of real numbers, helped consolidate the process of arithmetizing analysis. Mathematician Weierstrass opened new opportunities in mathematics for women, and Sonya Kovalevsky was the first woman mathematician who benefited from the scheme.



Albert Einstein

Until Einstein, space, time, mass and energy were all considered absolute and independent. Energy and mass were thought to have no effect on each other and were separately observed. However, the fact was challenged by Einstein who saw a metamorphosis – that all are inter-related. This paved the way for his magical mass-energy equation $E = mc^2$, where E = energy released, m = mass converted and c = speed of light = 3 lakh kilometer per second. Einstein's greatest gift to mankind was his invention of the theory of relativity.

Glorious Tradition of Indian Mathematics

India too had a long mathematical tradition, initially in the religious context of astronomy, first recorded by Baudhayana during c. 800-600 BC. Later mathematician Aryabhatta in the late 5th Century and Brahmagupta in the early 7th Century wrote important works involving arithmetic, algebra and trigonometry, whose influence spread to the West in succeeding centuries.

In the 9th Century, Baghdad was an important centre of mathematical activities, where Al-Khwarizmi wrote many books, drawing together Babylonian, Greek and Indian influence. His arithmetic introduced the Indian decimal place-value numerals. By the late 12th century much mathematical knowledge had been developed.

An Italian with trading link to Sicily, Fibonacci, noticed that the Arabs were using much more efficient numerals, and wrote his book, *Liber abaci*. Chinese mathematician Yang Hui explored binomial pattern and Chu Shih Chieh took the arithmetical algebra style to a new height. In India, Bhaskara wrote valuable works on arithmetic, algebra and trigonometry, and Madhava during c. 1340-1425 headed a research tradition in Kerala whose work on infinite series and trigonometric functions got global recognition. In Iran, Omar Khayyam (c. 1048-1122) worked to develop arithmetic, algebra and geometry as well as astronomy and philosophy.

The Exploration Continues

During the 20th Century much new mathematics was developed, partly through exploring structures common to a range of theories, thus counteracting the tendency to split into more and more distinct specialized areas. Topology, under the considerable influence of Poincare, reached new heights of geometrical generality and unifying power, while algebra too became even more general in its exploration of structural depth.

The development of electronic computers, particularly associated with Turing and Von Neumann, grew out of mathematical, logical and number handling activity and affected mathematics in a variety of ways. Recent exploration of mathematics which uses the computer as a research tool can be seen as restoring mathematics to its roots as an experimental science. And thus the glorious tradition of inventions in mathematics still continues . . .

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Maths Play

WALLACE JACOB

Question 1. Given that X, Y and Z denote single digit integers in the range of 1 to 9, what are the values of X, Y and Z in the following equation:

XYZ + ZYX = YYZY.

Solution: [Note: The above question falls into a class known as Cryptorithms. There is a sub-class of such questions known as Alphametics. Alphametics are essentially Cryptorithms that make sense when read, for example, SEND + MORE = MONEY, because its letters form words which are used in day-to-day life.]

In questions like these it is assumed that (i) there is a one-to-one mapping i.e. the same letter always denotes the same digit and the same digit is denoted by the same letter, (ii) different letters denote different numerals and (iii) there are no leading zeroes.

The Left Hand Side of the equation suggests that both XYZ and ZYX are three-digit numbers and the Right Hand Side indicates that YYZY is a four digit number which implies that the first Y from the left, in YYZY, is a carry-over digit.

Now, if we add only two digits in the range of 0 to 9 the minimum carry can be zero and the maximum carry can be one. For instance 4 + 5 = 09 (the carry digit is 0) and 9 + 9 = 18 (the carry digit is 1).

Therefore the value of Y is 1.

The equation (XYZ + ZYX = YYZY) also suggests that Z + X = YY (looking at the first and last letters from the left); which implies that the following form is valid:

```
   Y '! carry
  XYZ
+ ZYX
 YYZY
```

Therefore, Z = Y + Y + Y = 3. This implies that 3 + X = 11, thus the value of X is 8.

Question 2. What are the values of A, B, and C in the following equation:

AB x 4 = CA.

Solution. What is evident from the question is: (i) AB and CA are necessarily two digit numbers, and

(ii) AB should be less than or equal to 24. Why? Because 25 x 4 = 100.

Which implies that the value of A is either 1 or 2 and the value of B can be any value from the set {0,1,2,3,4}.

Also, if A is 1, then B cannot be 1; and, if A is 2 then B cannot be 2 as each letter corresponds to a different digit.

(iii) CA is an even number, because CA is the product of AB and 4. Therefore A is necessarily an even digit, which implies that the value of A is 2.

(iv) In CA, the value of A is 2. This implies that B should be 3 or 8. Why? Because 3 x 4 = 12 and 8 x 4 = 32. To get 2 in the unit's place it is necessary to multiply 4 by a number which contains 3 or 8 in the unit's place.

(v) From the discussion above, clearly the value of B cannot be 8, hence the value of B is 3.

(vi) 23 x 4 = 92

(viii) Therefore, A = 2, B = 3 and C = 9.

Question 3. If ALFA + BETA + GAMA = DELTA, then what are the values of ALFA, BETA, GAMA and DELTA?

Solution:

```
  ALFA
  BETA
 +GAMA
 DELTA
```

From the question it is evident that A+A+A = CA where C is for the carry digit. If we add the same digit thrice and the unit's digit of the result is the same digit, then obviously the digit has to be 0 or 5; because 0+0+0=0 and 5+5+5=15.

Obviously, the value of A should be 5, because 5 + 5 + 5 = 15 (the last digit from the left in ALFA, BETA, GAMA and DELTA is A). One more possibility is that the value of A might be 0, because 0 + 0 + 0 = 0. But since there are no leading zeroes herein, obviously the value of A should be 5.

Substituting A = 5, the equation takes the following form:

```
 5LFA
 BET5
+G5M5
DELT5
```

D can be either 1 or 2 because D indicates the carry digit. Assuming D = 1, we get the following form:

```
 5LF5
 BET5
+G5M5
1ELT5
```

Now, 1 + F + T + M = CT ...(1) where C represents the carry-digit obtained on adding 5+5+5.

C1 + L + E + 5 = L ...(2) C1 represents the carry-digit obtained on adding 1 + F + T + M

and C2 + 5 + B + G = 1E ...(3) C2 represents the carry digit obtained on adding C1 + L + E + 5.

From (1), it follows that 1 + F + M = 10, because on adding 10 + T, the unit's digit of the answer will be T.

Therefore F + M = 9

So F and M can have any one of the following values:

(9,0), (8,1), (7,2), (6,3), (5,4), (4,5), (3,6), (2,7), (1,8), (0,9).

But, neither F nor M can be 5 or 1 (as we know A=5 and D=1),

If we add only two digits in the range of 0 to 9 the minimum carry can be zero and the maximum carry can be one. For instance 4 + 5 = 09 (the carry digit is 0) and 9 + 9 = 18 (the carry digit is....

therefore the following combinations are ruled out: (8,1), (5,4), (4,5), (1,8).

That means F and M can take values from the following set:

(9,0), (7,2), (6,3), (3,6), (2,7), (0,9). [Let us call this Inference 11, for convenience]

From (2), it follows that C1 + E + 5 = 10. Assuming that the carry-digit, C1 is 1, then E = 4

Substituting A = 5, D=1, E=4 the equation takes the following form:

5LFA
B4T5
+G5M5
14LT5

Assuming the value of C2 as 1, it follows from (3)

1 + 5 + B + G = 14.

Or B + G = 8.

Therefore, B and G can have any one of the following values:

(8,0), (7,1), (6,2), (5,3), (4,4), (3,5), (2,6), (1,7), (0,8).

From the discussion above, it is clear that the possibilities (7,1), (5,3), (4,4), (3,5) and (1,7) can be safely ruled out because A=5, D=1, and E=4.

Which implies that the values of B and G can be drawn from the set (8,0), (6,2), (2,6), (0,8). [Let us call this Inference 12, for convenience]

From **Inference 11** and **Inference 12,** the values of F and M can be 9 and 0 (or 0 and 9); the values of B and G can be 6 and 2 (or 2 and 6), since each letter corresponds to a unique digit.

The following values are known:

A	B	D	E	F	G	L	M	T
5	6	1	4	9	2	?	0	?

Therefore, the equation takes the following form:

5L95
64T5
+2505
14LT5

Only two variables L and T and three values 3,7,8, are left.

Suppose L = 3 and T = 7, then,

5395
6475
+2505
14375

Alternatively, if L = 7 and T = 8, then,

5795
6485
+2505
14785

Thus, for this question multiple solutions are possible.

Question 4. Two engineers (say A and B) from a premier institution meet each other after eleven years. The following conversation takes place between them:

A: How are you?

B: Great! I am married and I have three daughters.

A: Wow! How old are they?

B: The product of their ages is 72 and the sum of their ages is the number written over there (Points to a number which only A and B can see)

A: Difficult to figure out the ages.

B: My eldest daughter celebrated her birthday yesterday

A: Well. My eldest daughter is also of the same age.

What are the ages of B's daughters?

Solution: From the question it is evident that the product of the ages is 72 and the sum is a number which we do not know. Let us determine the ages that yield a product of 72.

Product	Sum
1, 1, 72	74
1, 2, 36	39
1, 3, 24	28
1, 4, 18	23
1, 6, 12	19
1, 8, 9	18
2, 2, 18	22
2, 3, 12	17
2, 4, 9	15
2, 6, 6	14
3, 3, 8	14
3, 4, 6	13

We get a **sum** of 14 if the factors are 2,6,6 or 3,3,8. In all the other cases we get a distinct and different sum. Therefore, A gets confused. But when he is told that the eldest daughter celebrated her birthday, then he understands that the elder ones are not twins and hence rules out 2,6,6 and can make out that their ages are 3, 3, 8.

Question 5. A 5-digit number has the following feature:

If we put the numeral 1 at the beginning, we get a number three times smaller than if we put the numeral 1 at the end of the number. Which is this 5-digit number?

Solution: Let Y denote the five-digit number.

3 x (100000 + Y) = 10Y + 1. Adding 100000 puts a 1 at the beginning of the number. Multiplying by 10 and then adding 1 puts a 1 at the end of the number.

Therefore, 300000 + 3Y = 10Y + 1

implies that 7Y = 299999

which means Y = 42857.

Contributed by Mr Wallace Jacob, Sr. Assistant Professor at Tolani Maritime Institute, Induri, Talegaon-Chakan Road, Talegaon Dabhade, Pune, Maharashtra – 410507; Email: wallace_jacob@yahoo.co.in

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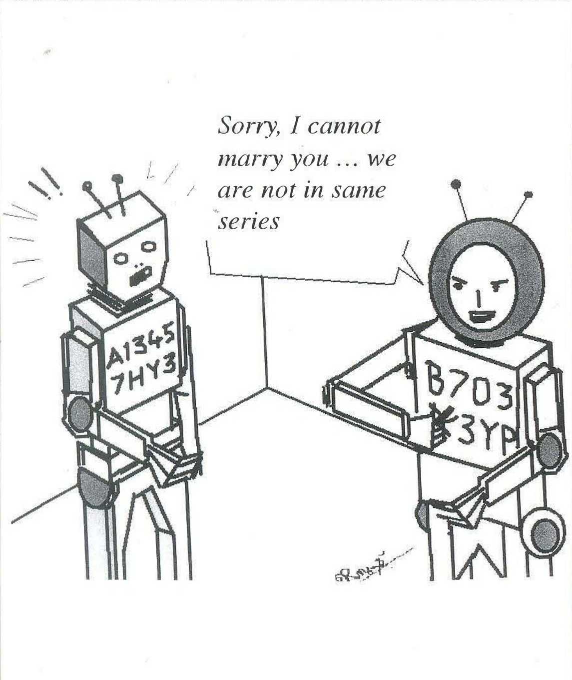

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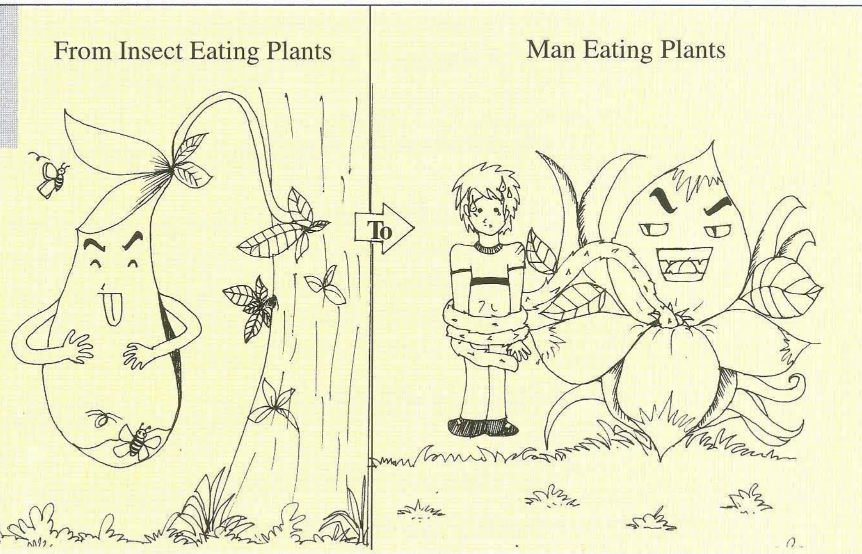
HEIGHTS OF EVOLUTION!!



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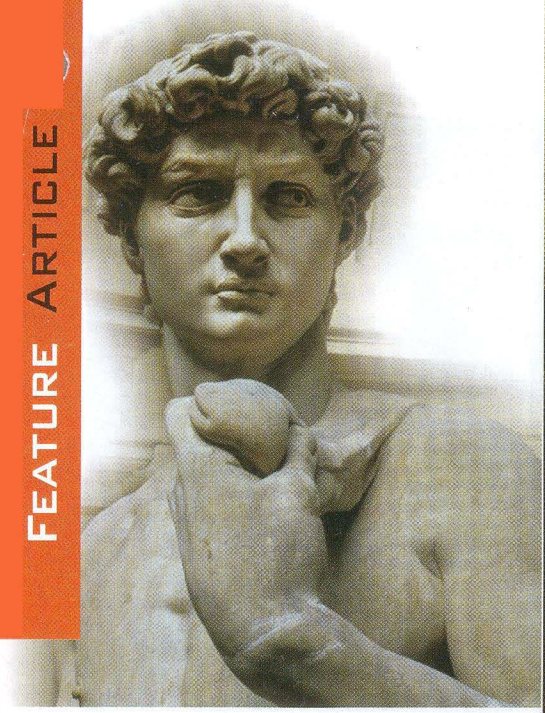
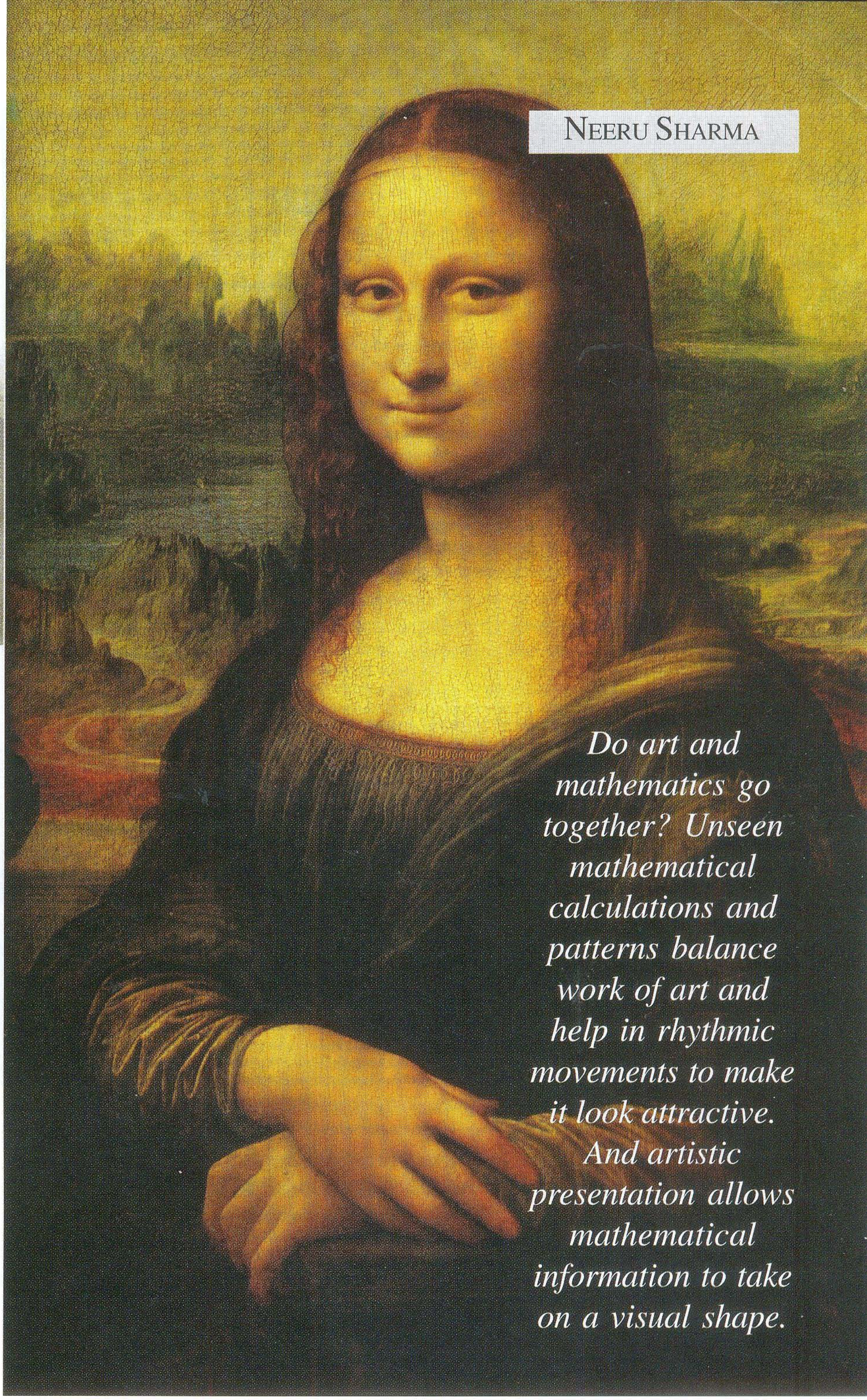


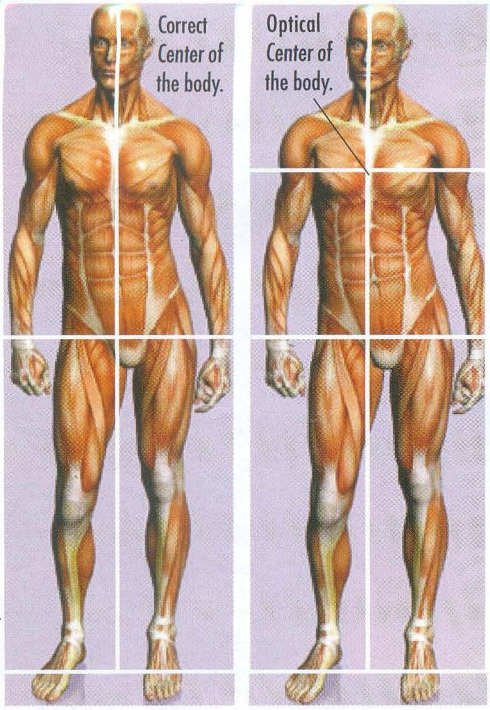


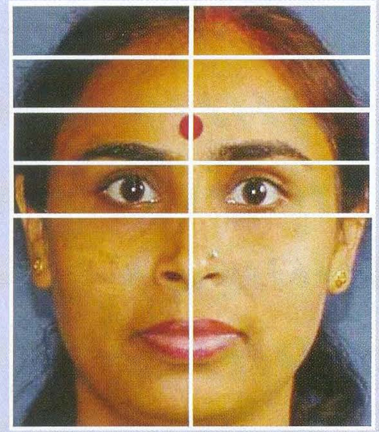
Mathematics in Art?

PAINTINGS, graphics, and photographs lend colour and beauty to walls, advertisements, magazines, and publications. But which is the best out of many, and why, is often determined based on mathematical calculations.

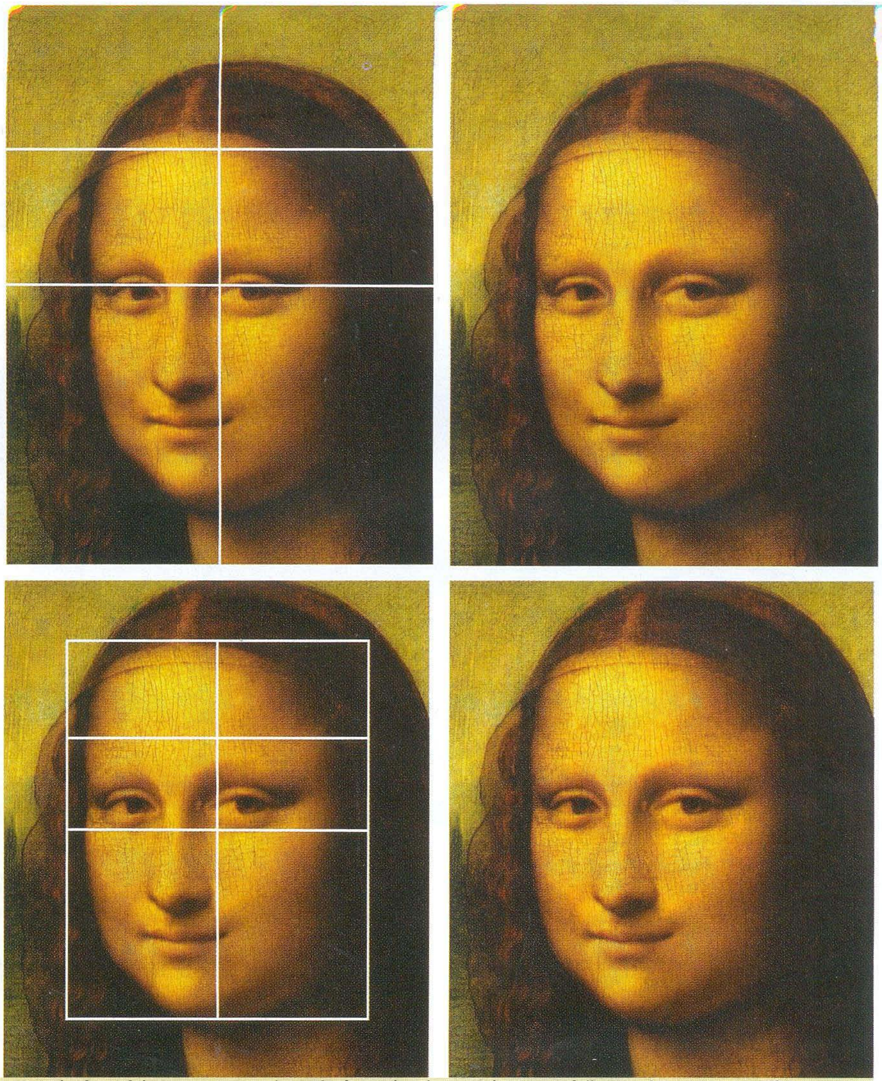
In fact, art and mathematics have always shared a long and close relationship. The ancient Egyptians and Greeks knew about the golden ratio, regarded as an aesthetically pleasing ratio, and incorporated it into the design of monuments including the Great Pyramid, the Parthenon, the Colosseum. Many artists have been known to have been inspired by mathematics and studied mathematics as a means of complementing their works.

Mathematical tools have always been used in the creation of art. Since ancient times, mathematical tools have combined with the imagination of the artist to create beautiful designs realized in the architecture and decoration of palaces, cathedrals, temples, and mosques. The





Optical Center of the face. Eyes, the most important part, are above the true center and near the optical center of the face. *Bindi* worn by Indian women brings more attrection in the face as it is placed on the optical center of the face



Top: The face of the painting 'Monalisa'. The faces placed on top shows eyes falling on the exact center of the potrait, there is more unnecessary space on top making the face sink down. If so much space is required above the head than double space is required below to make the portrait look balanced.
Above: In the above portraits the face is optically centered giving a feel of good balance.

Greek sculptor Polykleitos prescribed a series of mathematical proportions for carving the ideal male nude.

In fact, our most universal standard of measurement is the human body. We judge the appropriateness of size of objects by that measure. To lend balance to a piece of art the artist often tries to position the image at the optical center, which may not necessarily be the mathematical centre. A correct center may be very important for architectural designs but it may not be the same in visual art like paintings etc. If the center is drawn or the subject is placed in the exact center, the created art may look immature.

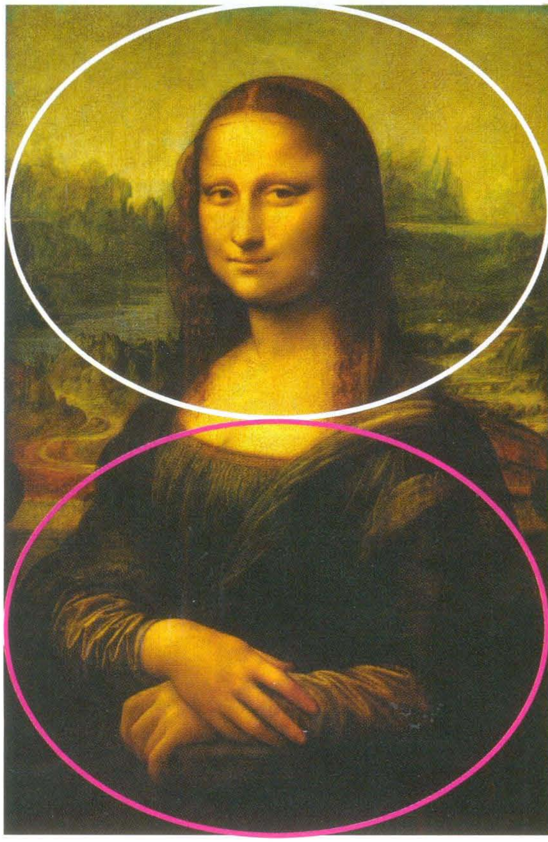
To make a shape or image look right in the given area, it requires to be balanced with space around it. But putting the shape in the exact center of the given space will not give the best result. The reason: the human eye doesn't see a mathematically perfect center as correct. Instead, it will give an illusion as if the shape is set low or out of balance and the work of art – whether a painting, a page layout or an advertisement loses the 'wow' factor.

Hence, the shape needs to be drawn or placed optically centered to make it look correct and balanced. The optical center is always the place just above the centre of any space/area. Any shape, element placed on the optical center gives the feel of a correct center and thus looks balanced. It is not only this center but also many more facts that determine the aesthetic value of any work of art or design.

The Optical Center

The human brain is used to view things the way nature has created. The best example is the shape of the human face and body. If we try to find out or analyze the center point of the human body, we see optically the center of the body in the center of the torso. This is a very important part of the body where the heart and lungs are placed – both the organs are very vital for human life.

Optical center is a position slightly higher in the given space or a page than the true center line. However, it must remain an equal distance from the left and

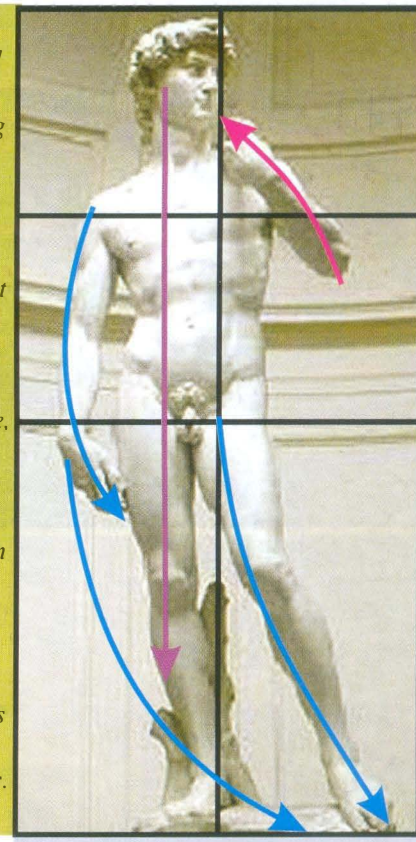


Monalisa is a beautiful painting and researchers and art critics have studied it in numerious ways. The painting is found to be balanced in everyway - optical center, colour depth as well as in rhythm.

***Optical Center**: The main part of the painting, the face is falling on the optical center, besides, the correct center of the face, the center of the nose, is on the optical center of the complete painting.*

***Balance**: The painting is almost divided in two through colour depths as shown by drawn ellipses.*

***Rhythm**: Look into her eyes, then come down the angle of her left hand, the viewer's eyes then take a loop along her right hand and come upwards.*



'David' famous statue by Michelangelo has the beauty through the perfact match of optical center, balance and rhythm. While whole weight of the body is on one leg (shown in dark magenta) the movement of rhythm dawnwards (shown in blue curves) is balanced by a small upward action/curve (shown in magenta curve) that takes the viewers eyes to the attractive face of statue.

right. There is a simple calculation to find out the optical center. First, measure the top-to-bottom height and width of the paper/canvas/space. Divide this height and width into half and draw lines. Divide the top half into ten parts. Depending upon the shape and size of the item/element to be drawn, the optical center can be anywhere between $1/10^{th}$–$5/10^{th}$ of the distance of half the page above the true center point created by crossing the vertical and horizontal line in the beginning.

Art of Balancing through Calculations

Visual art in any form has to look balanced for it to interest the reader or viewer and look attractive. In science, balance is the concept of visual equilibrium that relates to our physical sense of balance. Any good artistic composition can achieve balance in one of two ways: **symmetrically** or **asymmetrically.** The reconciliation results in visual stability. An artist, painter or sculptor can balance while visualizing or drawing a work of art with various designing elements like shapes, space and colours, apart from the main subject.

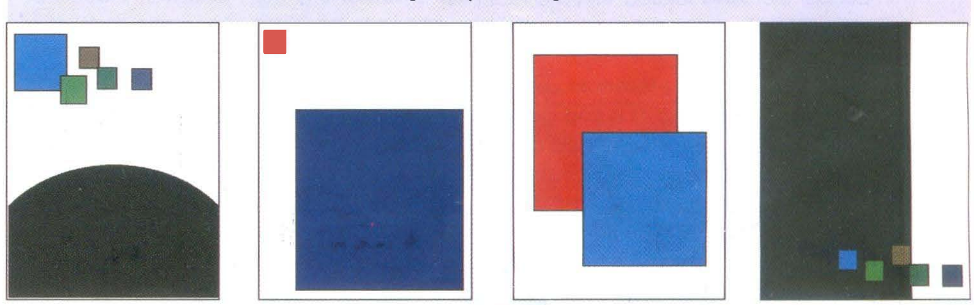
It is like walking. When a man puts a foot forward to take a step, the entire body gets into motion: one arm goes backwards, the other forward and simultaneously the other foot gets ready to take yet another step. The same is the case with art, the moment one item is shifted or drawn the rest also needs to take a position to maintain the rhythm and balance in the painting.

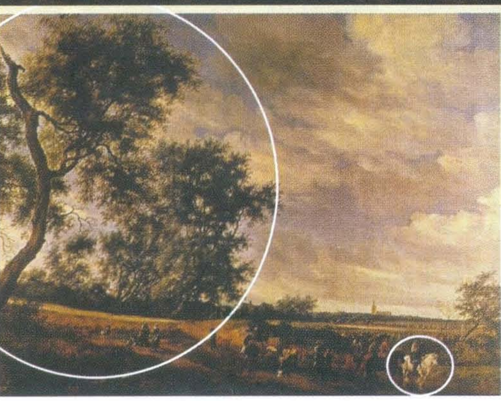
The art of calculation of balancing is much more required when the work of art has more than one component, like in the case of painting a landscape. The objective is to create a balanced composition of all the items of the landscape. There are various ways. For

PRINCIPLES OF GOOD COMPOSITION

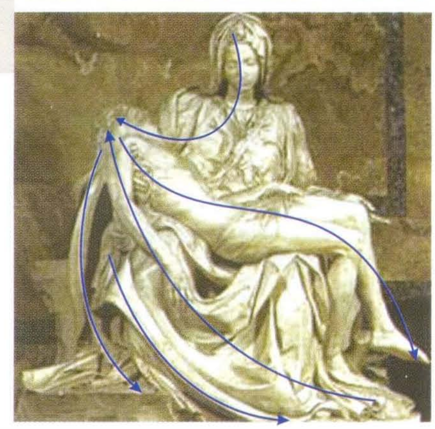
- Balance
- Proportion
- Rhythm
- Emphasis
- Unity

Balancing the objects in the given area





A famous landscape (above). The big tree on the left, which is covering almost half of the painting and stretching till center of the painting is balanced by a small but bright horse rider in the right foreground (left).



The beautiful and famous statue of 'Pieta' by famous sculptor and painter, Michelangelo, has perfect balance, optical center and rhythm (right)

instance, if there is a large component in the subject, it will always come near the center of the space/canvas. This large component can be balanced very well with a small sharp component near the opposite corner. When there are two equally important components, they can come together or even overlap each other.

Role of White or Blank Space

In art, white space is not to be considered merely 'blank' space – it is an important element of design that enables the objects in it to exist in balance. There has to be a balance between the positive, the subject (image), and the use of negative space with only some colour, colour strokes, non-important elements related with the main subject like clouds, curtains, birds etc. in the background.

However, these elements are not painted to the extent of hundred percent finishing. These small elements help create excellent painting/design/layout/illustration which are the keys to aesthetic composition. The appropriate use of the negative space not only gives balance to the positive space (actual image) in a composition but is also considered by many as good design as it gives breathing space. When it breathes, it is alive, as with any living organism. This basic and often overlooked principle of design gives the eye a "place to rest," increasing the appeal of a composition through subtle means.

The Rhythm

Rhythm is the term given to the movement of eyes within the area of composition or painting. It is a kind of scale to measure the quality of any work of art. Just as living beings are fascinated by the good rhythmic notes of music, similarly good rhythm in the painting gives aesthetic pleasure to the viewer.

When any item is drawn, placed or added in the given space, the brain of a good designer automatically adjusts the rest of the shapes and images, keeping intact the importance of the main subject. Just as the human brain helps balance the human body by appropriate movement/action of the body without falling, in the same manner the brain also guides the designer/artist. A good artist can exactly visualize the contents of the painting or work of art first in the mind and then on paper/canvas or stone.

The fundamental of any composition is that the total impact of the visual should be composed and compact. There should be some rhythm in the placed components. Colours and even brush strokes help in creating the rhythm in the work of art, which helps in making a painting or art piece look balanced. With this characteristic, the viewer's eyes move within the area of the painting making it look more attractive.

Ms Neeru Sharma is the Graphic Designer of *Science Reporter* and is also Principal Technical Officer at NISCAIR, CSIR.

Prize Puzzle

FOLLOW THE CLUES

Using the clues given below, find the names of nine animals. Pick up one letter from each of the names as instructed and you get the name of a nocturnal, herbivorous rodent with long erectile spines covering its body.

Clues

1. Poisonous snake with scales on the head
   (Pick up the third letter)
2. Common amphibian found in pools of water
   (Pick up the third letter)
3. Marine elasmobranch fish
   (Pick up the fourth letter)
4. Common black coloured bird
   (Pick up the first letter)
5. Australian ratite bird
   (Pick up the third letter)
6. Biggest and longest non-poisonous snake
   (Pick up the first letter)
7. Largest of the living apes of Africa
   (Pick up the fourth letter)
8. Largest of the living marsupials
   (Pick up the third letter)
9. Snake-like fish
   (Pick up the first letter)

ANSWER

Contributed by Dr K. Venkatraman, Retired Reader and Head of Department of Zoology, Madura College.
Address: A-T-2 Porkudam Apartments, Bypass Road, Madurai-10

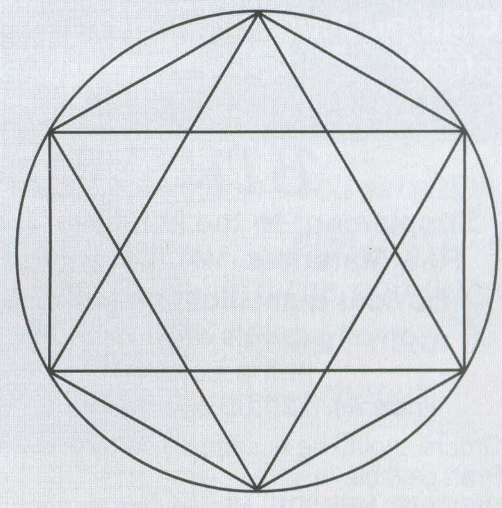
ALPHA-NUMERIC SUDOKU

	4			6	5		7			D	0			3	E
1					C	2		4		3		B	5		
5		6				1	D		2		F			4	9
	2	0	7		4	B	3	6		1	5	A		C	F
			E	C			B	D	3				4	A	
	5	7		9	3			2				F			
				7	2		4			9	C			E	
	1			D	F	E	0	A			6	9			3
7	3	2		B			F	8		6					
			6			4	A	9		2		D		5	
B		1	D		9	6		E	0		4		2		
A		4	F		8						1		C	0	7
	7	A	2					0				C	3	9	1
9						C	8		4	A		7	F	B	
	F				1	7	9		6						
3		B				0	5	7		F			E		6

Contributed by Mr Vijaya Khandurie, Address: A-2/603, Glaxo Apartments, Mayur Vihar Phase-1 Extension, Delhi- 110 091

HOW MANY TRIANGLES?

How many triangles do you see in this figure?



Contributed by Mr ASR Murthy, Sr, Engg. Assistant, Doordarshan Relay Centre, Devarakonda-508248

SOLUTIONS TO PUZZLES PUBLISHED IN THE FEBRUARY 2012 ISSUE

PRIZE PUZZLE:

THE PHILATELIST

She has a minimum of 15 stamps.
India: 1 blue, 2 red, 4 unknown colour
France: 2 blue, 3 red, 1 unknown colour
Unknown country: 1 purple, 1 red

ALPHA-NUMERIC SUDOKU

2	3	E	5	9	8	1	B	4	6	0	7	D	F	C	A
1	6	0	B	A	C	4	2	F	8	5	D	E	9	7	3
7	F	4	A	D	0	3	E	9	B	C	2	6	8	5	1
8	D	C	9	7	6	F	5	1	3	E	A	2	4	0	B
0	E	7	6	C	3	A	1	B	2	D	8	9	5	4	F
A	C	F	3	2	7	0	D	6	4	9	5	B	1	E	8
4	2	5	1	B	E	8	9	C	0	3	F	A	D	6	7
B	9	8	D	F	5	6	4	E	7	A	1	3	0	2	C
6	0	9	4	1	D	7	F	5	A	B	C	8	E	3	2
F	A	D	8	E	2	5	6	7	9	4	3	C	B	1	0
C	1	2	7	3	B	9	0	8	F	6	E	4	A	D	5
5	B	3	E	8	4	C	A	D	1	2	0	7	6	F	9
3	5	6	0	4	F	B	C	A	D	7	9	1	2	8	E
D	4	1	2	5	A	E	8	3	C	F	B	0	7	9	6
9	7	B	F	6	1	2	3	0	E	8	4	5	C	A	D
E	8	A	C	0	9	D	7	2	5	1	6	F	3	B	4

THE WINNERS OF THE PRIZE PUZZLE BASED ON THE DRAW OF LOTS FROM AMONG THE CORRECT ENTRIES ARE:

1. **Chinmay Chhatani,**
   6/208, SFS, Agarwal Farm,
   Mansarovar, Jaipur-302020

2. **Amisha Yadav,**
   49 Srinagar, Galla Nadi,
   Naubasta, Kanpur-208021

3. **Debjyoti Majumdar,**
   P-87, Indraprastha,
   70/25 Jessore Road (South),
   PO Barasat, Dist. 24 Parganas (N)-700127

CONGRATULATIONS
ALL THE WINNERS!

NATASHA DAS & JUHI NACHANE

Yuvraj Singh has been diagnosed with 'extragonadal germ cell seminoma' – a form of cancer. But the good news is that it can be treated.

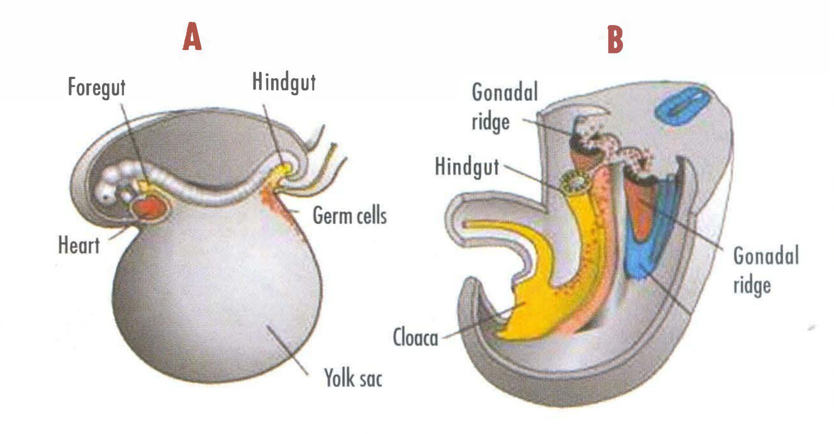
A Curable Cancer

ACE cricketer Yuvraj Singh is undergoing treatment for cancer. Earlier reports said it was a tumor in his lung. Now they say it is cancer but not lung cancer. Yuvi has 'extragonadal germ cell seminoma', a rare form of cancer. What, on earth, is this? Will Yuvi be fine? Will he really be back on the crease again? Is it true that this form of cancer is curable? Is any cancer actually curable?

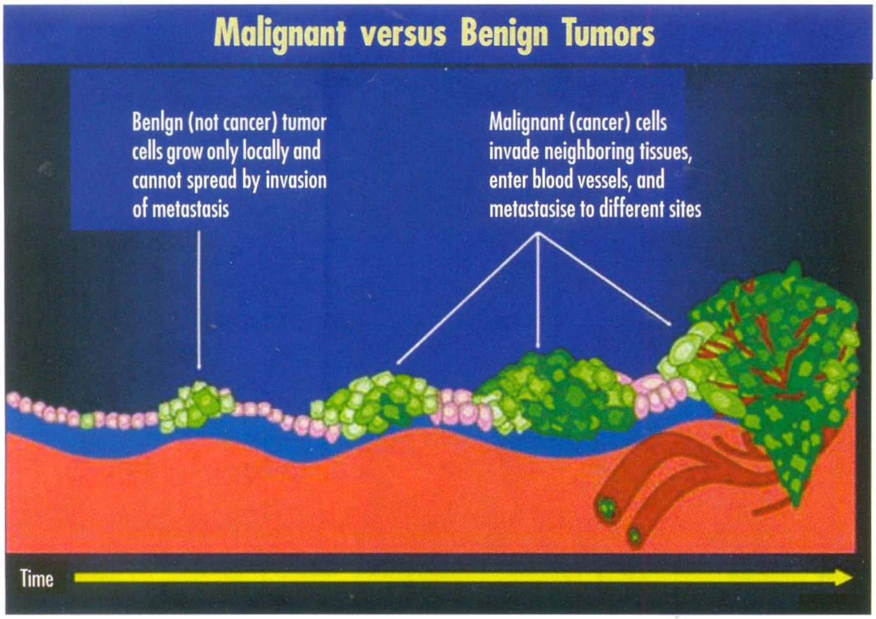
You've heard a lot about cancer...about blood cancer, especially in Bollywood movies... about breast cancer in numerous awareness programs in your city...about lung cancer or oral cancer in protests against use of tobacco... But 'extragonadal germ cell seminoma' is probably a new term for you.

The Germ Cell Path

A germ cell is a cell that develops into an egg or a sperm. To understand about extragonadal germ cell tumors, we need to understand about the development of the human gonads or the sex organs – the testes in males and the ovaries in females. Although the sex of a child is determined during fertilization, the development of



A. 3-week-old embryo showing the primordial germ cells in the wall of the yolk sac close to the hindgut.
B. Migrational path of the primordial germ cells along the wall of the hindgut into the gonadal ridge



male or female gonads does not occur until the seventh week of development.

In the embryo, when you are nothing but a mass of cells, even before the formation of the gonads, the germ cells develop near the hindgut. The gonads first appear as longitudinal ridges of tissue called gonadal or genital ridges. They extend from near the embryonic heart region to the cloaca, a common exit for the intestinal and urinary tracts. The cloaca splits into separate passages during later part of embryonic development.

The gonadal ridges are made from proliferation of epithelium (the kind of tissue that can grow into membranes, skin, nails and hair) and the condensation of mesenchyme (embryonic tissue that gives rise to connective tissues such as bones, muscles, blood etc). During the initial development, the gonadal ridges contain no reproductive tissue. Germ cells do not appear in the gonadal ridges until about the sixth week of development. As the nerve fibers grow, the germ cells migrate from behind the hindgut along these nerve fibers and reach the gonadal ridges. They arrive there at the beginning of the fifth week and invade the genital ridges in the sixth week.

If the germ cells do not reach the gonadal ridges, the gonads do not develop. They are therefore important for the development of gonad into the ovary or the testis. The presence of a gene on the Y chromosome that encodes the testis-determining factor, decides that the gonadal ridges must develop into a pair of testicles. If the gene is absent, the gonadal ridges develop into the two ovaries, instead.

The Extragonadal Destination

Do you remember falling from your bicycle and getting a swollen bluish green bruise on your forehead? In medical terms, even that bruise or an abscess or boil is a tumor. A tumor is simply a swelling or lump or aggregate of cells. Thus, a tumor isn't only a cancer. And a cancer isn't always a tumor. Many cancers present as lumps of tissue, and hence the term tumor is commonly used.

There are two main types of tumors – benign and malignant. Benign tumors are not cancerous. Malignant tumors are cancerous. Typically, a benign tumor grows only in one place. It does not spread or invade other parts of the body. A malignant tumor can spread and invade other tissue... sometimes spreading through the blood vessels to rather distant tissues.

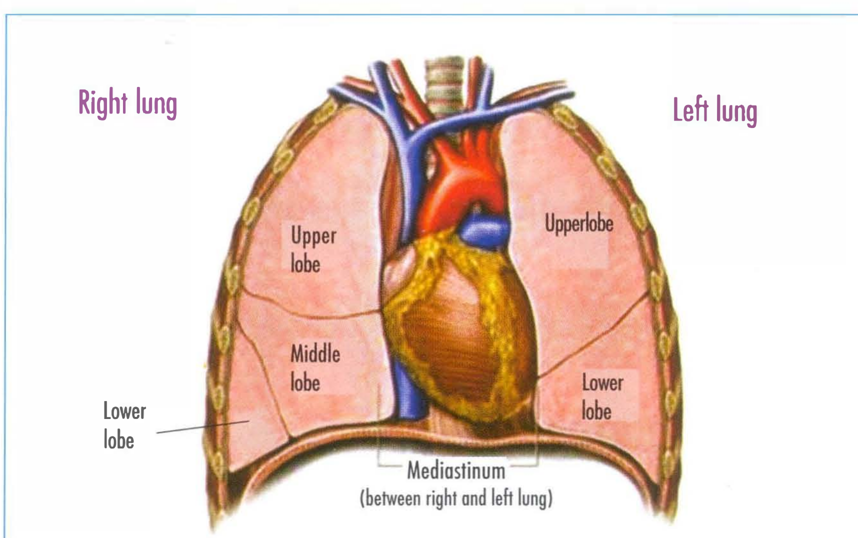
Germ cell tumors are formed most commonly in the testes. However, 2-5% of germ cell tumors can occur in other locations. When tumors of germ cells are formed outside the gonads, they are termed 'extragonadal germ cell tumors'. Initially, it was believed that these were tumors that originated in the gonads and spread through metastasis to other sites beyond the gonads (extragonadal sites). Current hypotheses suggest that these are congenital tumors, which actually originate outside the gonads.

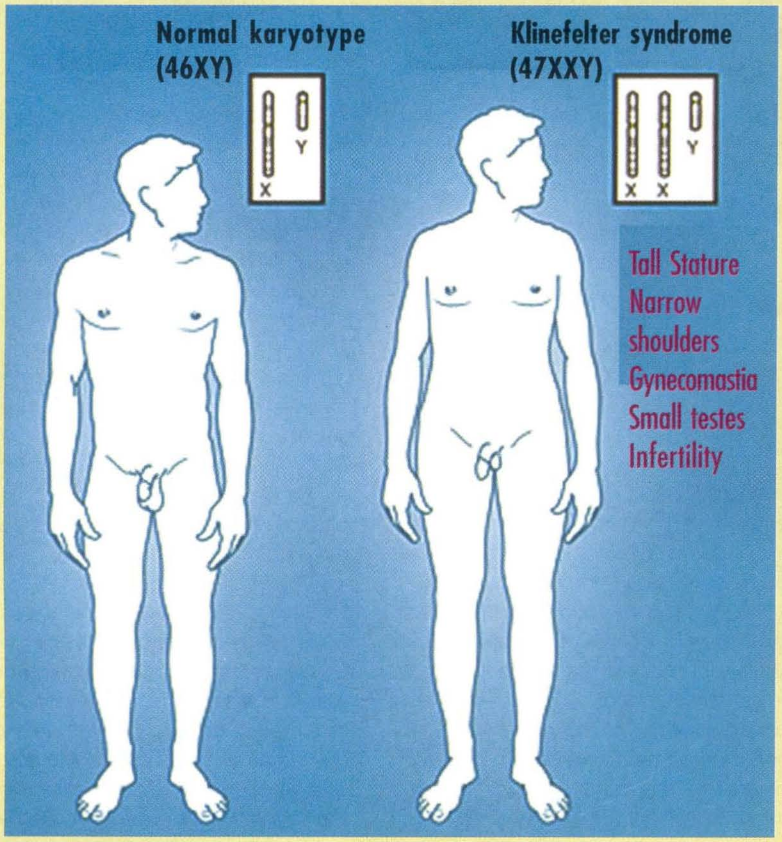
They can begin to grow almost anywhere in the body but usually occur along the midline. The most common locations include the pineal gland in the brain, the mediastinum or the abdomen.

The mediastinum is the central compartment of the thoracic cavity. It lies between the two lungs. It is the part of the body where lie the heart and its large vessels, the wind pipe, the food pipe, the thymus, lymph nodes, and other structures and tissues. Incidentally, the site of Yuvraj Singh's extragonadal germ cell tumor is the mediastinum. Before its actual location was correctly diagnosed, it was initially believed to be a lung tumor, which it is not.

A Rare Cancer

Extragonadal germ cell tumors are very rare. An extragonadal germ cell tumor may or may not be cancer. Most extragonadal germ cell tumors, almost 80%, are noncancerous. They grow very





Characteristic clinical findings in men with Klinefelter syndrome. Note that there are no facial characteristics that suggest a diagnosis of Klinefelter syndrome. Therefore, particular attention to physical examination of the body habitus is necessary for diagnostic consideration.

Source: http://www.aafp.org/afp/2005/1201/p2259.html

fast and are often very large. Such tumors can be removed by surgery.

While benign extragonadal germ cell tumors occur with equal frequency among males and females, the malignant ones occur predominantly in males (9:1). A cancerous extragonadal germ cell tumor may be either a seminoma or a nonseminoma. Yuvi has an extragonadal germ cell seminoma located in his mediastinum. Seminoma is a malignant tumor arising from sperm-forming tissue. Nonseminomatous germ cell tumors include all other germ cell tumors. Nonseminomatous germ cell tumors are more common (60-80%) while seminomas are less common (30-40%).

Risk Factors and Possible Symptoms

Whether you are born a male or female and your age can affect your risk of developing extragonadal germ cell tumors. A risk factor is anything that

Within a few months of completion of his chemotherapy, he is expected to be back on the cricket field with a fresh crop of hair and his ever-winning spirit.

Chemotherapy drugs are powerful drugs. Thus, chemotherapy causes hair loss. Fortunately, hair loss due to chemotherapy is only temporary.

increases your chances of getting the cancer. If you have one or more risk factors for the cancer, it does not mean you will get the cancer in question. It also does not mean that if you do not have the risk factors you will not get the cancer. It just means that you are at lower risk compared to somebody who has a particular risk factor. If you think you may be at risk, discuss it with your doctor.

Malignant extragonadal germ cell tumors occur more commonly in males. They are seen more often in men between 20 and 35 years of age. Another risk factor is a genetic disorder called Klinefelter syndrome. This is a genetic condition where a male is born with one or more extra X chromosomes, instead of the usual one X and one Y chromosome. Such males are described as XXY males. Klinefelter syndrome occurs in 1 out of 1,000 males. Many males with XXY chromosomes lead a normal life without ever knowing about it. Some of those with Klinefelter syndrome may have hormonal imbalance resulting in characteristic abnormalities. They have abnormal body proportions (long legs, short trunk, shoulder equal to hip size), abnormally large breasts called gynecomastia, infertility, sexual problems, less than normal amount of pubic, armpit, and facial hair, small and firm testicles and a tall height.

Malignant extragonadal germ cell tumors cause symptoms when they spread into nearby areas or press adjacent organs. The same symptoms may be caused by other conditions as well. It is advisable to consult a doctor if a person experiences any of these symptoms over a long period of time: chest pain, cough, breathing problems (specially, on exertion), fever, headache, change in bowel habits, feeling very tired, trouble walking, trouble in seeing or moving the eyes, weight loss, nausea, night sweats, hoarseness and abdominal mass with or without pain.

The first symptom that Yuvraj had was only a chronic cough. One-third of the patients with mediastinal seminoma may have no symptoms at all. Their mass may be discovered by a routine chest X-ray. Tumors as large as 20 to 30 cm in diameter can exist in the mediastinum without causing prominent symptoms.

A Curable Cancer

Doctors are saying that Yuvraj has a very rare cancer and the cancer is curable. It has a very good prognosis. A report published in a leading newspaper says that Yuvraj may be playing cricket again as early as May this year. Is it possible? Is any cancer actually curable? The answer is Yes! Cancer is curable. The prognosis of a cancer depends on several factors. These include the type of cancer, the stage of the disease and response of the patient to the kind of treatment provided.

Luckily, Yuvraj has a type of cancer that has a high cure rate. In comparison to nonseminomatous germ cell tumors, seminomas tend to grow much slower and spread less quickly.

The extent to which a cancer has spread is often described through staging. For extragonadal seminomas, prognostic groups are used instead. An extragonadal germ cell seminoma is believed to be in the good prognostic group if the tumor has not spread to organs other than the lungs. It is in the intermediate prognostic group if the tumor has spread to organs other than the lungs. There is no poor prognosis group for extragonadal germ cell seminoma.

With adequate treatment, in seminoma patients, a very good survival rate can be achieved...over ninety per cent at five years. Nonseminomas have a worse prognosis. Survival rate is around forty-five per cent at five years.

Treatment for extragonadal germ cell tumors includes three or four cycles of chemotherapy i.e., the use of anticancer drugs. The basic treatment strategy includes chemotherapy plus additional secondary surgery. Surgery may be considered if the tumor is more than 3 cm in diameter after the use of chemotherapy. Otherwise, only watchful waiting is needed after chemotherapy. If the tumor is only a small mass confined to one area, there may be no need for chemotherapy. It can be treated with radiotherapy and a careful follow up.

Why has chemotherapy caused Yuvraj to go bald? Will he regrow his hair again? Chemotherapy drugs are powerful drugs. They attack rapidly growing cancer cells. At the same time, they also attack other rapidly growing normal cells of the body – including the cells in the hair roots. Thus, chemotherapy causes hair loss. Fortunately, hair loss due to chemotherapy is only temporary. The normal cells of the body repair themselves. Within a few months after the chemotherapy cycles end, Yuvraj will regrow all his hair. The hair may temporarily be of a different shade and texture.

Yuvi has a rare but curable type of cancer. Within a few months of completion of his chemotherapy, he is expected to be back on the cricket field with a fresh crop of hair and his ever-winning spirit.

"In 2005, a man diagnosed with multiple myeloma asked me if he would be alive to watch his daughter graduate from high school in a few months. In 2009, bound to a wheelchair, he watched his daughter graduate from college. The wheelchair had nothing to do with his cancer. The man had fallen down while coaching his youngest son's baseball team."

– ***Siddhartha Mukherjee***, *The Emperor of All Maladies*

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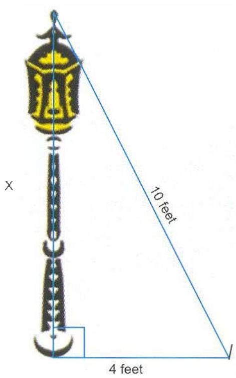
MATHEMATICS QUIZ

1. A light post, shown at the right, is set in concrete and supported with a guy wire while the concrete dries. The length of the guy wire is 10 feet and the ground stake is 4 feet from the bottom of the light post. Which equation could be used to find the height of the light post, x, from the ground to the top of the light post?

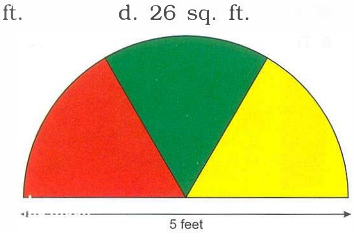


a. $x = 10^2 - 4^2$ b. $x = 10^2 + 4^2$

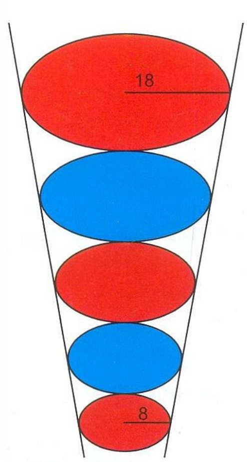
c. $x = \sqrt{10^2 + 4^2}$ d. $x = \sqrt{10^2 - 4^2}$

2. A cathedral window is built in the shape of a semicircle. If the window is to contain three stained glass sections of equal size, what is the area of each stained glass section? Express answer to the *nearest square foot.*

a. 1 sq. ft.   b. 3 sq. ft.
c. 13 sq. ft.   d. 26 sq. ft.

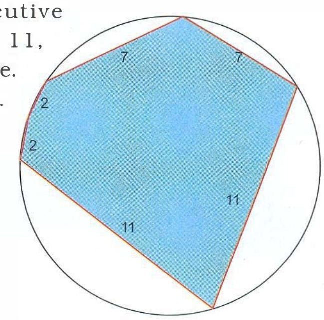


3. Five marbles of various sizes are placed in a conical funnel. Each marble is in contact with the adjacent marble(s). Also, each marble is in contact all around the funnel wall. The topmost marble has the radius of 18mm and the lowest one has the radius of 8mm. Find the radius of the middle marble i.e. 3rd marble.



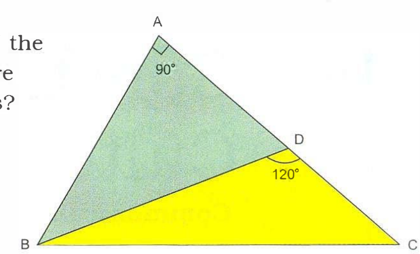
a. 10mm
b. 12mm
c. 14mm
d. 16mm

4. A hexagon with consecutive sides of lengths 2, 2, 7, 7, 11, and 11 is inscribed in a circle. Find the radius of the circle.



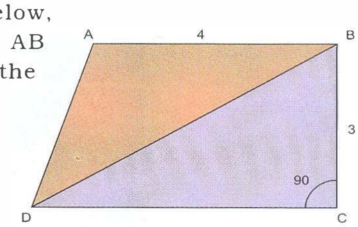
a. 3 units
b. 5 units
c. 7 units
d. 10 units

5. What is the length of the segment BD in the figure below, if AD is 5 inches?



a. 4 inches
b. 6 inches
c. 8 inches
d. 10 inches

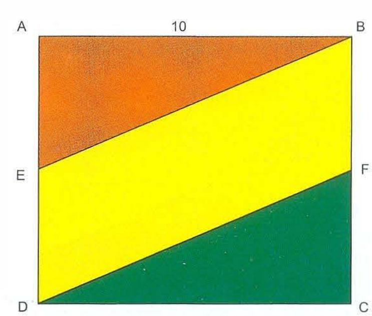
6. In the figure below, quadrilateral ABCD has AB parallel with CD. What is the area of triangle ABD?



a. 10
b. 6
c. 12
d. 3

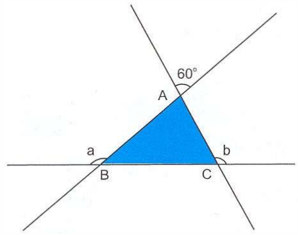
7. The side ABCD of the square is 10, AE=ED and BF=FC. What is the area of the parallelogram BFDE?

a. 10
b. 25
c. 50
d.75

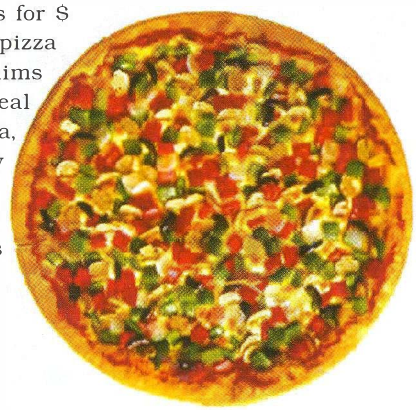


8. What is the value of the sum of the angles a and b in the figure below ?

a. 60
b. 120
c. 180
d. 240

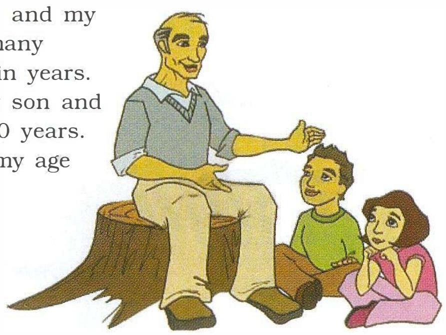


9. The 10" pizza sells for $ 5.99 at my favorite pizza store. The store claims they have a great deal on the large 12" pizza, which is specially priced at $ 7.33. What is the per cent discount the store is offering?



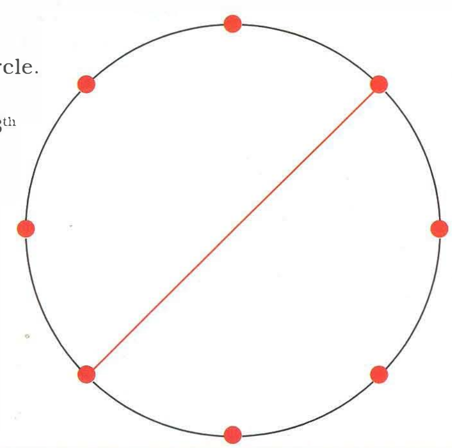
a. 10
b. 15
c. 20
d. 25

10. Grandpa: "My grandson is about as many days as my son is weeks, and my grandson is as many months as I am in years. My grandson, my son and I together are 160 years. Can you tell me my age in years?"



a.56
b. 66
c. 86
d. 96

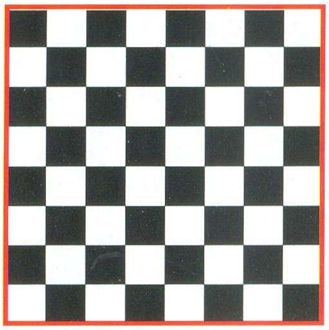
11. A number of children are standing in a circle. They are evenly spaced and the 8th child is directly opposite the 19th child. How many children are there altogether?



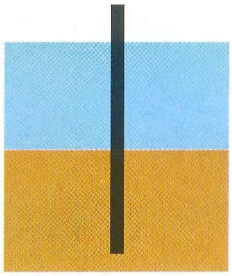
a. 22
b. 16
c. 20
d. 10

12. If you were to construct 6X6 checkered square (i.e., a 6X6 chess board), how many squares would there be in total?

a.36 b.64
c.72 d. 91



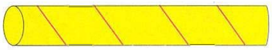
13. There is a pole in the lake. One-half of the pole in the ground , another one-third of it is covered by water, and 10 ft is out of the water. What is the total length of the pole of ft.



a. 20
b. 40
c. 60
d. 80

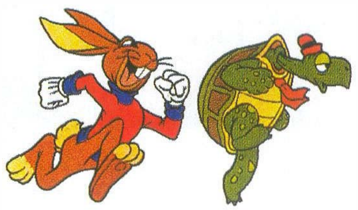
14. A cylinder 72 cm high has a circumference of 16 cm. A string makes exactly 6 complete turns round the cylinder while its two ends touch the cylinder's top and bottom. How long is the string in cm?

a. 60
b. 80
c. 100
d. 120



15. Haretown and Tortoiseville are 70 miles apart. A hare travels at 8 miles per hour from Haretown to Tortoiseville, while a tortoise travels at 2 miles per hour from Tortoiseville to Haretown.If both set out at the same time, how many miles will the hare have to travel before meeting the tortoise en route?

a. 56
b. 46
c. 50
d. 40



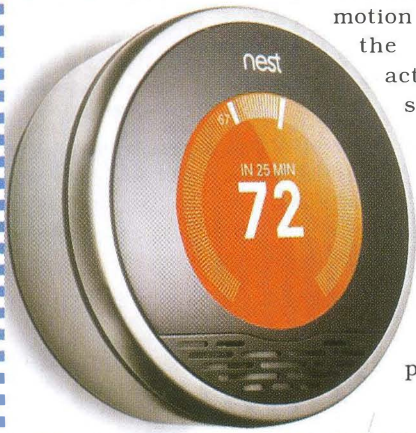
Answers:

1. d	**2. b**	**3. b**	**4. c**
5. d	**6. b**	**7. c**	**8. d**
9. b	**10. d**	**11. a**	**12. d**
13. c	**14.d**	**15. a**	

Compiled by Mr Nitin Kumar Ahir, Research Intern, *Science Reporter*, NISCAIR, New Delhi

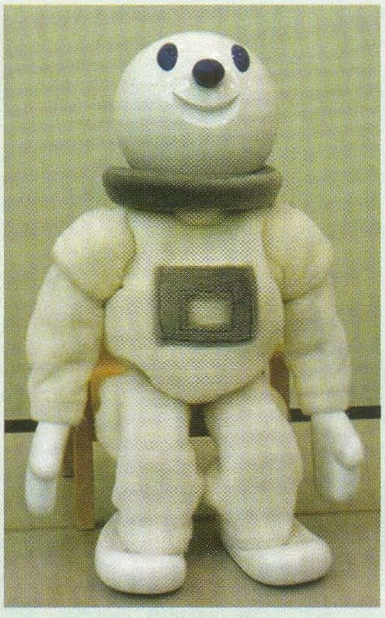
Artificially Intelligent Thermostat

Programmable thermostats help save money by resetting the temperature. But setting them up can be painstaking, and 89 percent of users never get them out of manual mode. For the first week, users change the temperature normally. To account for conditions outside, it checks the weather over Wi-Fi, and its indoor humidity sensor tells it when to kick in the fan for comfort. If everyone leaves, a motion sensor signals the processor to activate the away setting. A change of a single degree from the preset program can reduce power consumption by 2 to 5 percent.



Giraffe Street Lamp

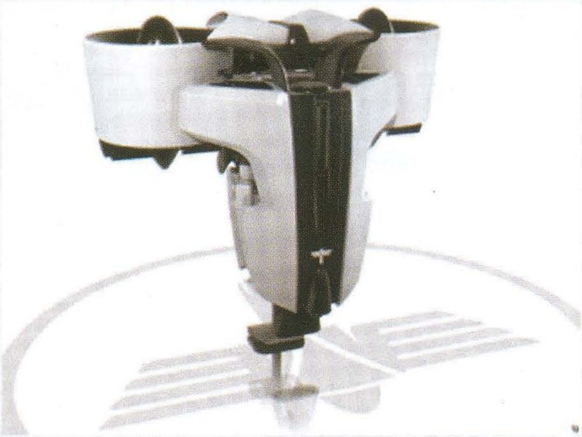
An odd new concept street light has turned up called the Giraffe Street Lamp that has a light high up on the neck and a swing underneath. This unusual concept uses the swing to capture the kinetic energy generated by swinging people to power the light. The design is interesting and works well on a playground for kids with swinging providing the light to use when it's dark. The light also has a solar panel on top for supplemental energy collection, but the creators say that the storage of kinetic energy is much more efficient than solar power.



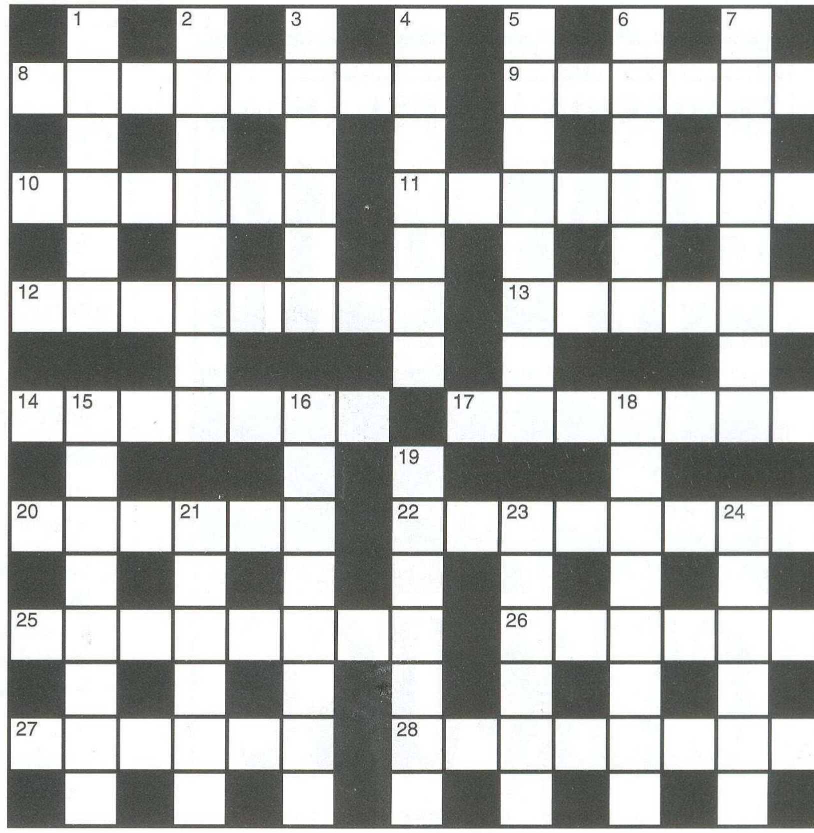
Taizo: A Humanoid Robot to Help the Elderly

The researchers have unveiled a new humanoid robot named Taizo, to motivate elderly people to engage in more physical exercise. Dressed in a velvety space suit, the 70-centimeter tall robot with his funny appearance is sure to appeal to the elderly. With 26 joints in its body, this mechanical instructor can easily demonstrate around 30 different moves. Taizo performs most exercises sitting on a special chair but if required he can stand and perform various activities as well. The 7-kilogram robot has very basic language skills, enough to understand simple spoken commands and lead a group in exercise. On a single charge Taizo can run for about 2 hours.

Martin Jetpack



Before few years, it is vague that we can fly ourselves but now we can fly by using the jetpack on our back. This latest technology jetpack can fly up to 8000 feet which is enough for the most of the people and their wants. With the help of this jetpack you will be able to fly maximum 31.5 miles. This Martin Jetpack can fly at the speed of up to 63 mph. This technology has dimension of 468 ´ 351 and this Jetpack need full tank of gases for the half and hour flight.



ACROSS

8. Biological process whereby genetic factors are transmitted from one generation to the next (8)
9. Elementary particle having mass equal to or greater than that of a proton and participates in strong interactions (7)
10. A conically shaped utensil used to channel the flow of substances into a container with a small mouth (6)
11. Minute organisms lacking chlorophyll that reproduce by fission; important as pathogens and for biochemical properties (8)
12. Rectifier that extracts modulation from a radio carrier wave (8)
13. American inventor of the gyrocompass (6)
14. Medical procedure involving an incision with instruments (7)
17. Scottish geneticist who contributed to the development of population genetics; became an Indian citizen (7)
20. A plane curve generated by one point moving at a constant distance from a fixed point (6)
22. Main organs of photosynthesis and transpiration in higher plants (7)
25. The second largest of Jupiter's satellites (8)
26. A keyboard that is a data input device for computers (6)
27. The outer and thinner of the two bones of the human leg between the knee and ankle (6)
28. A region with an abundance of oil wells extracting petroleum from below ground (3, 5)

DOWN

1. The seedpod of a leguminous plant such as peas, beans or lentils (6)
2. His contributions to the unification of the weak force and electromagnetism won him Nobel Prize with Abdus Salam and Glashow (8)
3. Small seed of an annual cereal grass (6)
4. A wave number characteristic of the wave spectrum of each element (7)
5. The value of a coordinate on the horizontal axis (8)
6. Home of Archimedes (6)
7. The only anti-particle having a definite name (8)
15. A white crystalline product of protein metabolism; found in the blood and urine (4, 4)
16. Resistor for regulating current (8)
18. The process to remove toxic substances from the bloodstream, used in the case of kidney failure (7)
21. The characteristic of quarks that determines their role in the strong interaction (6)
23. A water-soluble compound capable of turning litmus blue (6)
24. Communicates electronically on the computer (1-5)

Contributed by Mr Vijaya Khandurie, A-2/603, Glaxo Apartments, Mayur Vihar Phase-1 Extension, Delhi-110 091

SOLUTIONS TO MARCH CROSSWORD